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Exploring Electronics And Technology For The Hobbyist And Professional

September 1998 Vol. 19 No. 9

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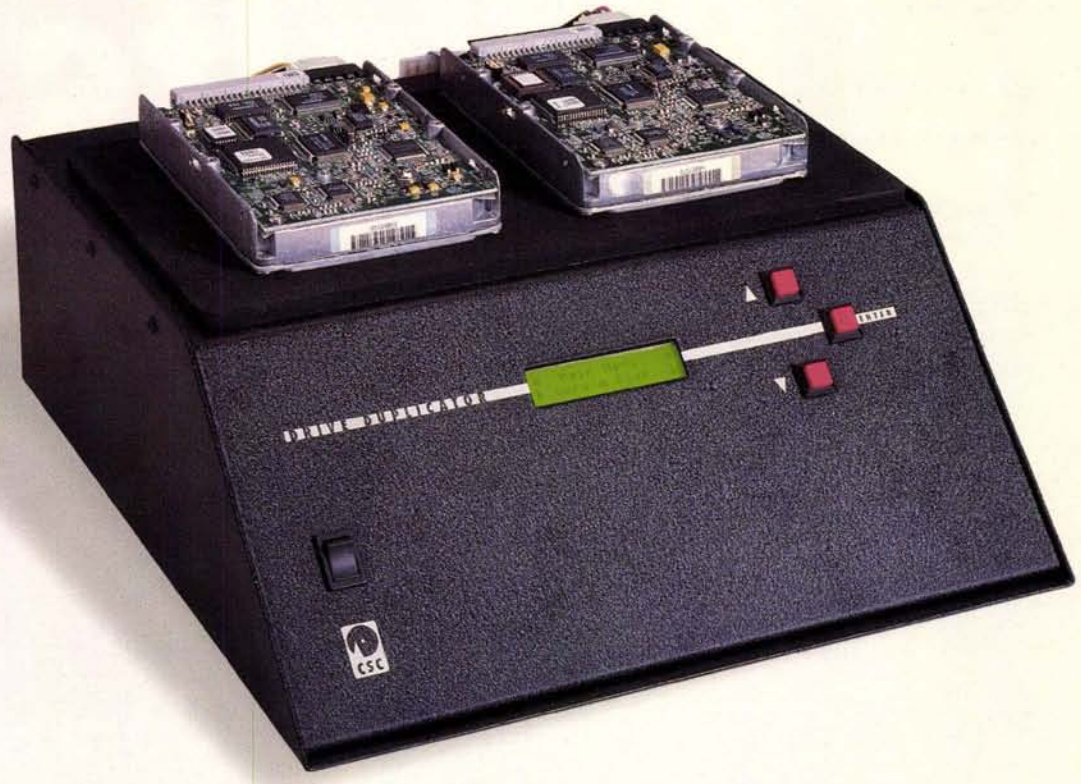

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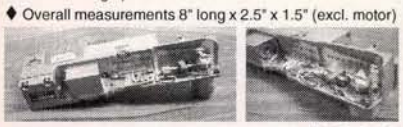

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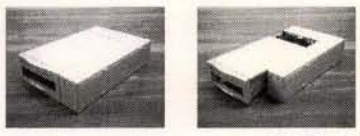

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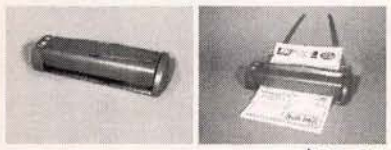

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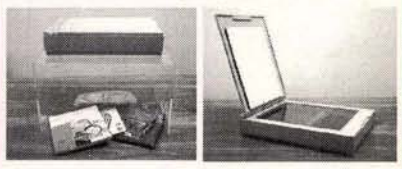

HSC#17392 **$49.00**

Video-hacker Dream!

- Logitech Videoman Video-conference camera & interface
- These units were sold with Hewlett Packard S-700 workstations for videoconference capability
- We do not have technical data, software or manuals
- All we have is cameras with stand, and SCSI-II interface
- The camera is on a weighted stand that extends from 13" tall to over 20" tall, and has a stereo microphone
- Color camera is digital output only (not NTSC) as far as we can tell -- but who knows?
- Interface box has two SCSI-II ports on back, and a DC power input (we do not have the adapter), and on the front it has a mic. out jack, composite video out (BNC), and the connector for the camera cable.
- Be the first one to provide us with some usable data on getting these things to operate, and we will give you five sets of camera and interface box! All parts are new!
- Note: HP and Logitech will provide no information on these

HSC#17503 **$39.95**

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- 9-pin plug has power input as well as video -- weird!
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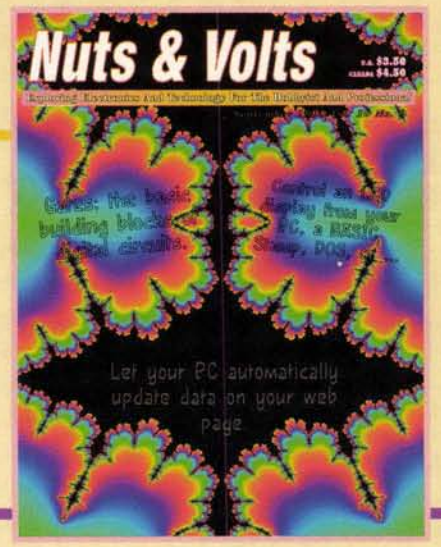

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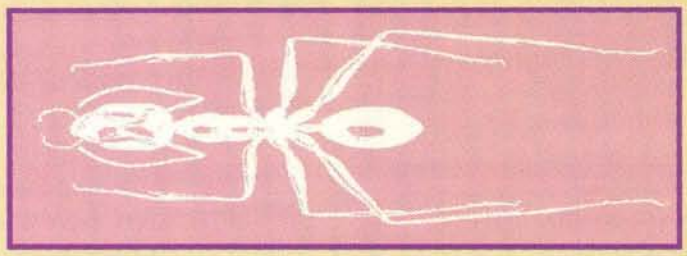

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Deadlines should be discussed in advance with the editor, but generally all material should be submitted two weeks prior to the 1st of the month for the next month's issue.

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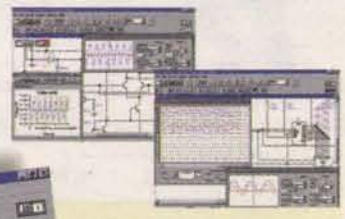

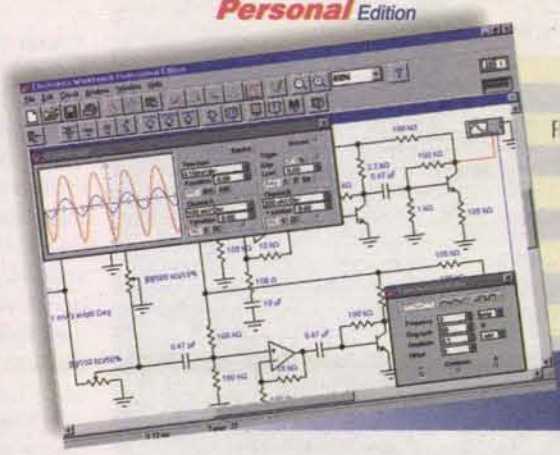

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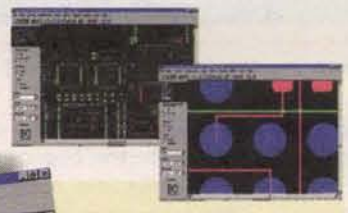

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HAM RADIO LOOPS

by Gordon West

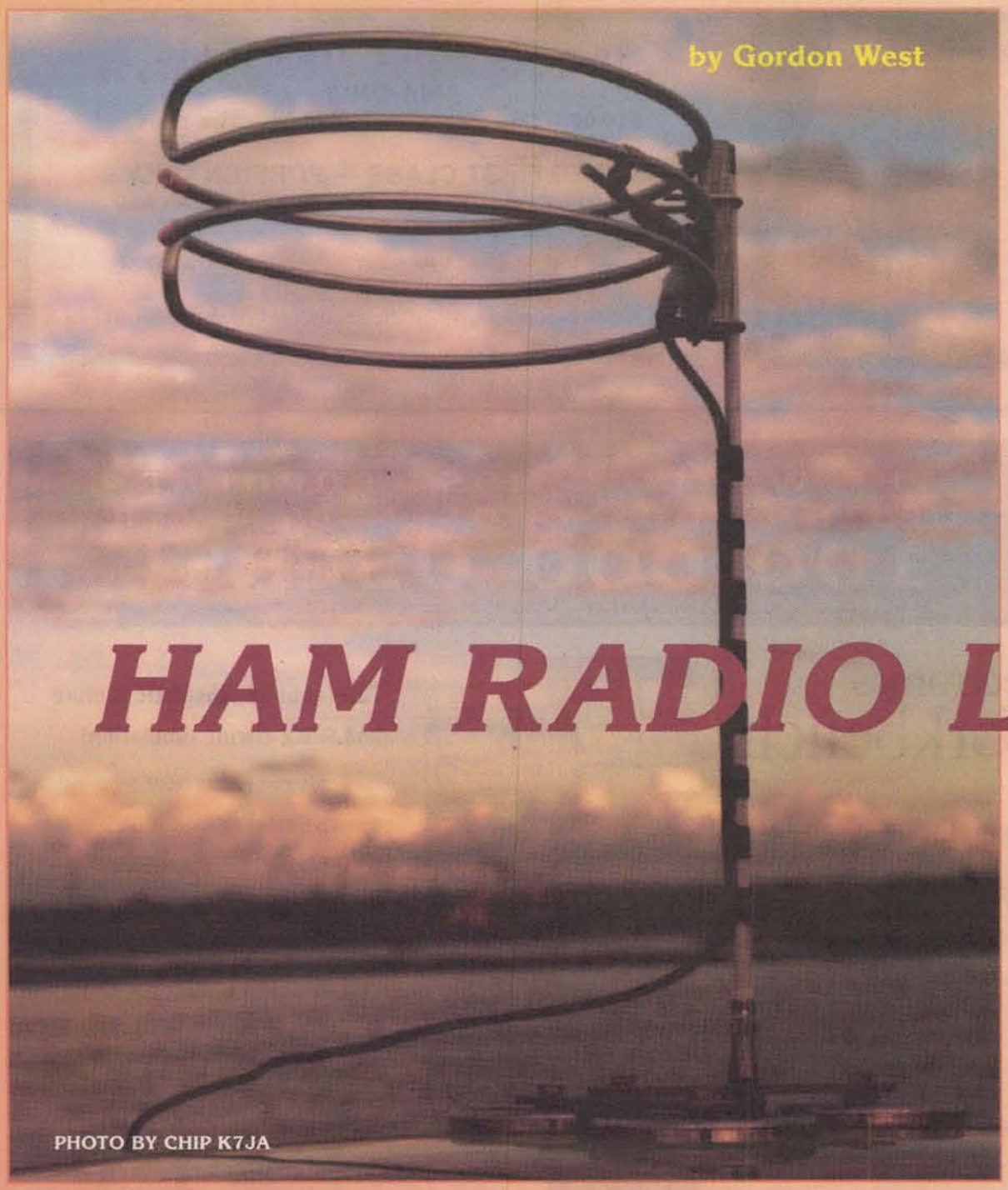


PHOTO BY CHIP K7JA

Sometimes ham operators cannot put up a BIG antenna system. And there may be the amateur operator who may prefer to go horizontal with the radiation pattern, but from his or her mobile unit. And getting a lot of signal out of a small antenna is relatively tricky when you use capacitive loading as opposed to a heat-dissipating, signal-losing loading coil.

Enter the loop. Sometimes called a mobile halo. Sometimes configured as three loops to be called a turnstile.

CRAWL SPACE LOOPS AT HOME

Maybe you live in an apartment or condominium where your only access to the roof area is a small crawl space above your closet. Or maybe you need to hide the antenna in a cupola sometimes found in older homes before restoration.

For high-frequency, 12 MHz-30 MHz operation, a company called AEA developed the ISOLOOP. This was an amazing antenna — I say "was" because AEA has now split off into different fields — because it was remotely tuned to cover any and all frequencies from about 12 MHz up to 30 MHz.

A motor-driven proprietary capacitor would resonate the compact loop to a point where SWR was at a minimum, and power into the flat-loop element was at a maximum. In fact, you could draw a dandy spark from a lead pencil when the antenna hit resonance.

If ever you see an AEA isoloop on a swap-meet table, grab it up if they are selling it for less than $100.00. But chances are, you will need to open up the black plastic housing and realign the little capacitor drive belt that always seems to slip off. I don't know if there are any spare parts for this antenna, but everything is relatively straightforward except for the proprietary remote-control unit.

Another loop for high frequency is available from ham radio accessory manufacturer MFJ. The MFJ Model 1782 and Model 1786 cover 10 through 30 MHz, and put out an amazing signal that is just short of what you might get out of a full-length halfwave dipole. MFJ also makes a loop that covers the 40-meter ham band, Model 1788. Similar in size to the AEA loops (about five feet across), the MFJ loops do an amazing job of getting the signal out on high frequency that must be confined to crawl space in an attic.

These high-frequency loops are extremely high-Q. Where a dipole might cover 500 KHz of 40-meter operation, these high-Q, high-frequency loops may only cover 25 KHz. So you will need to do some careful adjusting of the remote controller in ord er to get the big capacitor inside the loop exactly where you need it for minimum SWR and maximum signal transfer. But once you find that "sweet spot," you'll have a relatively good signal that comes close to what you might have with a halfwave length dipole at about the same elevation.

Of course, the loop only works in an attic if the roof is shingle, asphalt, or tile. The loops won't work worth a darn under anything that is conductive.

For more information about the MFJ loops, contact the factory at 601-323-5869, and request their full line catalog.

These high-frequency loops all feature a motorized tuning capacitor to achieve resonance. But as we go higher in frequency, set capacitance can easily cover the prime weak-signal voice and CW operating portions of the band.

A 10-meter, fixed-capacitance loop has just been developed by Norm Pedersen KB6KQ, who I call the "super loop guy." Pedersen is a retired design engineer, and he home-brews individual loops that cover 10 meters, another one for six meters, his very popular two-meter super-loops, and a loop for the 432 MHz ham band. All of his loops are handmade, and feature fixed capacitance to resonate at the lower portion of the band, specifically on HF, VHF, and UHF weak-signal sections of the band.

The 10-meter loop is giant — it stands about six feet tall, and is designed for roof-top mounting. There is no way you could get it in your attic because it's way too large to get up into the crawl space.

When compared to a 10-meter dipole, the

The winner in two-meter signal strength — a pair of stacked KB6KQ loops.

loop achieves a definite edge. And unlike a dipole that is bidirectional, the 10-meter KB6KQ super-loop radiates in all directions. It is

The ICOM Funmobile on the air with two-meter loop on 144.200 SSB.

massive — but if you're looking for a compact way to get on 10 meters at your home, consider the KB6KQ 10-meter loop.

"I am working anybody that I can hear," comments Western States Weak Signal Society member Larry Frakes KG6EG. "On this loop I have worked three new states, two new countries, and I have 20 new 10 10 numbers. I have it clamped to the corner of my tower about 24 inches below my two-meter Yagi, and it works just great," adds Frakes.

A week later, Larry indicates he now has 31 states, and added over 100 new 10 10 numbers. "I don't have room for a high-frequency Yagi, so this 10-meter loop is doing just what I wanted," adds Frakes.

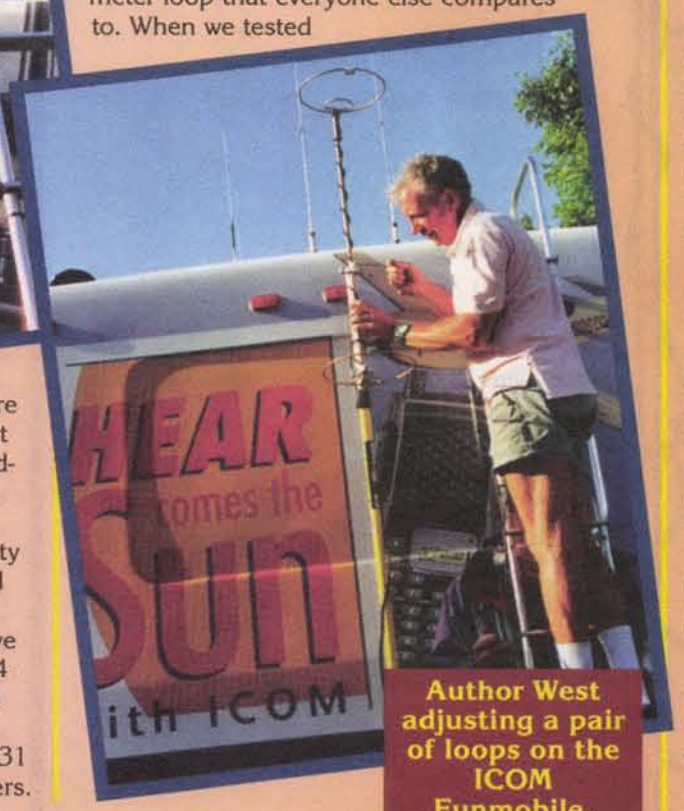
Up on six meters, loop size gets more manageable — the six-meter KB6KQ loop is just 24 inches in diameter, and sells for under $100.00. It, too, features a fixed-capacitance tuning scheme, but like the 10-meter loop, you can squeeze or tug on the parallel capacity plates and set yourself up on any frequency throughout either band. But the way it comes from KB6KQ, the plates are separated to put you right down at the weak-signal portion of the band where most operators are on the air with CW or single-sideband, upper sideband.

You can receive information sheets about KB6KQ loops by contacting Norm in Carson City, NV at **702-885-7885**, or looking up his antennas on the internet at kb6kqnorm@aol.com.

Up on the two-meter band, loop size is now getting very manageable — about 11 inches in diameter with fixed capacity resonance. But up on two meters, the KB6KQ loops have some big competition.

VHF/UHF well-known antenna expert, Mike Staal K6MYC, and a family-run business called "M2" do a terrific job of providing hams with six-meter and two-meter square loops called "SQLOOPS." (M2 Antenna Systems, Fresno, CA; 209-432-8873; E-Mail: m2sales@aol.com.)

The M2 two-meter sqloop is characterized by an all-black covering to protect the inside capacitive loaded elements from detuning in rain. The design has been around for many years, and it still continues to be "the" two-meter loop that everyone else compares to. When we tested



Author West adjusting a pair of loops on the ICOM Funmobile.

the KB6KQ loop to the M2 sqloop, performance was almost identical. However, the streamlined KB6KQ two-meter loop must be seen to be appreciated.

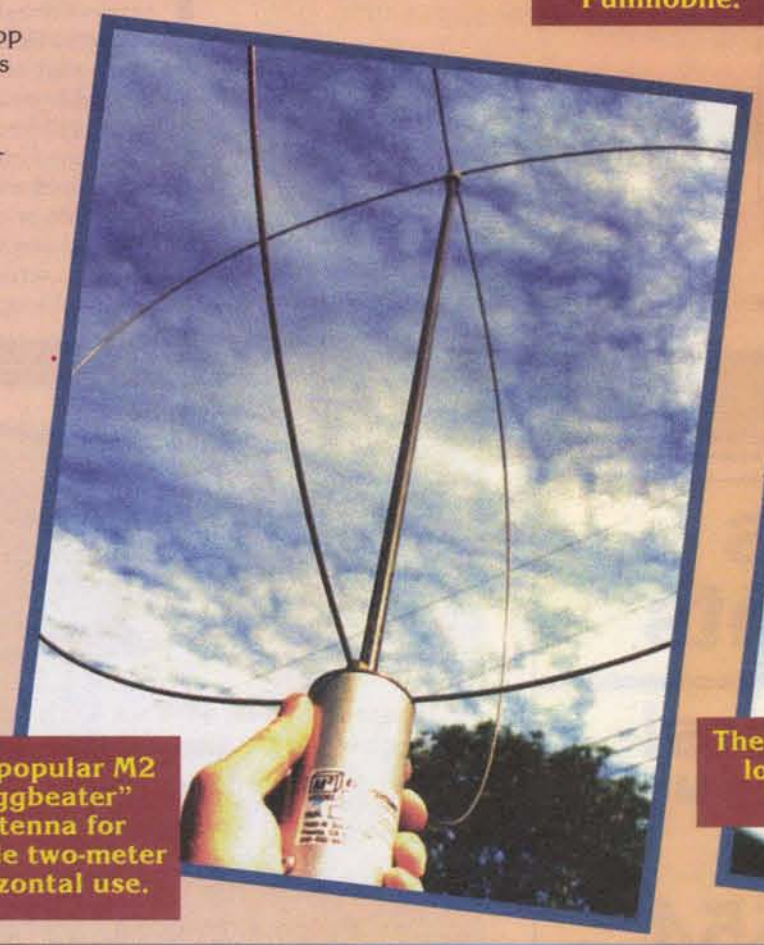
Another interesting loop comes from Par Electronics (Lantana, FL 561-586-8278). Par is best known for their filters, and their two-meter loop is actually a triangle. "Our omni-angle series of antennas accomplishes what the halo and turnstile started out to do — providing a clean omnidirectional, horizontally polarized signal. Range tests showed the typical halo to be 5.5 dB out of omni; turnstiles were even worse, and lower in gain. Halos attempt to achieve omni by bending and shortening a dipole into a loop shape. The shortcoming narrows the band width considerably," comments Par Electronics.

When we tested the Par omni-angle, two-meter loop, it worked well — almost identical to the performance of the similar-sized M2 sqloop and the KB6KQ super-loop. It assembles easily, and we think they will sell well in the Florida area where hams typically talk from Florida to Texas via tropospheric ducting on the two-meter band, mobile!

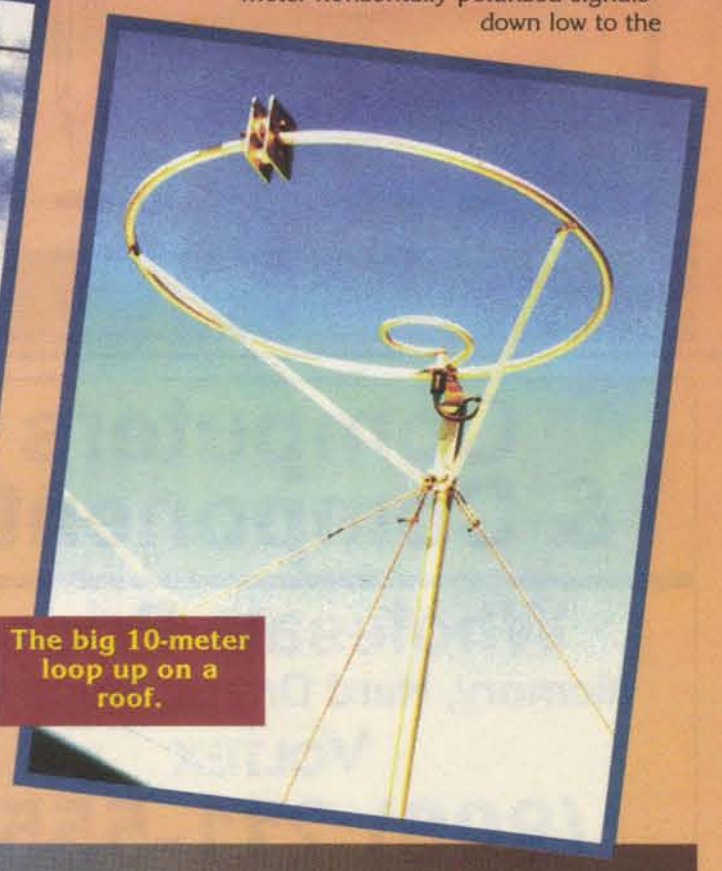
Another interesting antenna, a turnstile, comes from Laddy N8EWU, out of Oceanside, CA. The "Laddy Turnstile" is relatively large and cumbersome for mobile operation, but they work extremely well for omnidirectional, horizontal polarization, when stacked one above the other and phased for collinear feed.

The Western States Weak Signal Society (P.O. Box 86, Downey, CA 90241) net control station, David Peters KI6FF, operates four "Laddy Turnstiles" from his home QTH, and regularly reaches out several hundred miles conducting the Sunday evening Western States Weak Signal Society net on 144.240 MHz at 8:00 p.m.

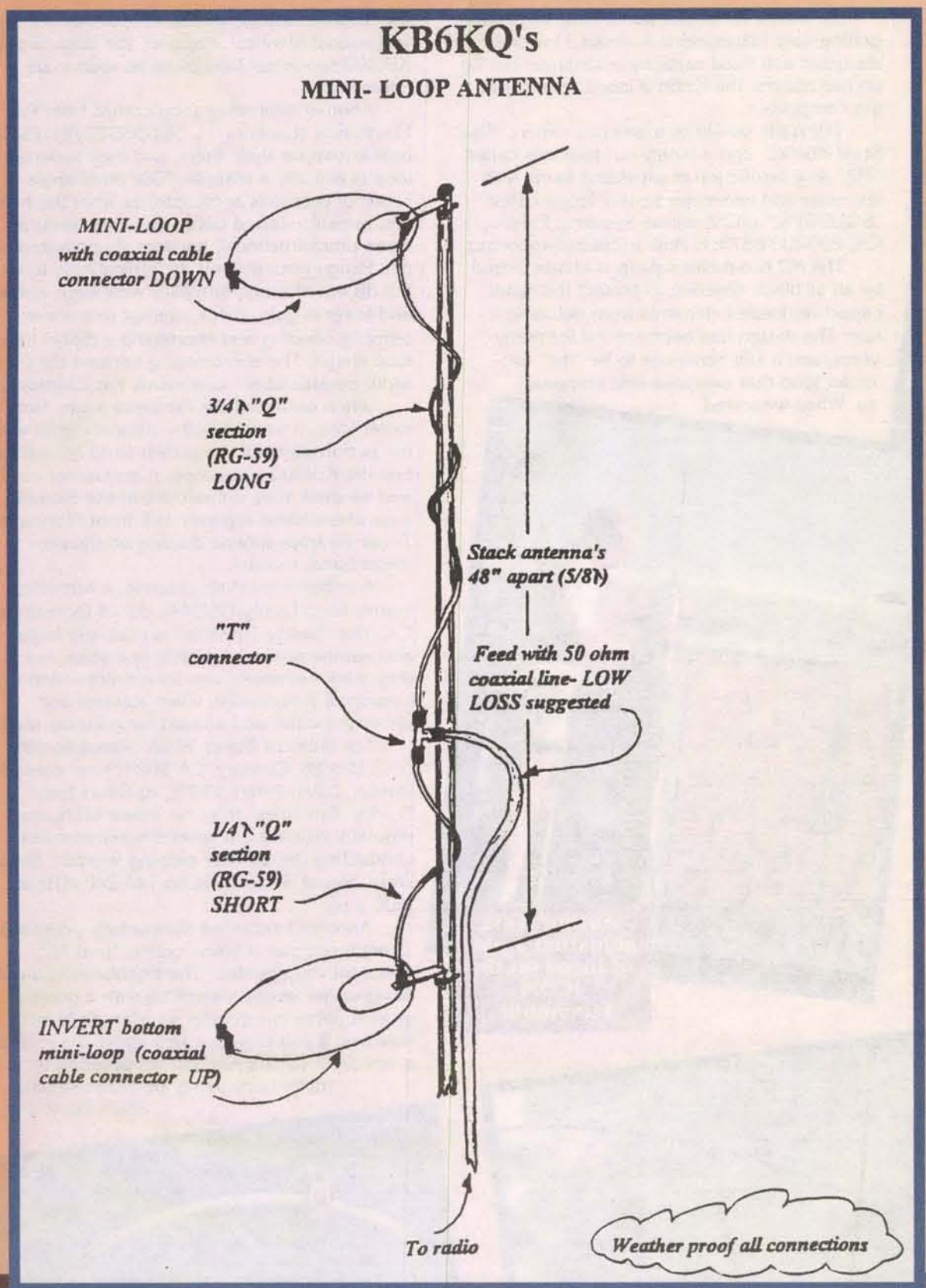
Another interesting horizontally polarized, omnidirectional antenna comes from M2, called the "Eggbeater." The Eggbeater is more designed for working satellites with a good ground plane one-quarter wavelength below. However, if you elevate it well above the roof of a vehicle, it does a nice job of capturing two-meter horizontally polarized signals down low to the



The popular M2 "Eggbeater" antenna for mobile two-meter horizontal use.



The big 10-meter loop up on a roof.



horizon. If you're looking for a strange antenna system, consider the Eggbeater from M2 Antennas.

Up on the 432 MHz band, manufacturers are just beginning to develop a line of loops. But most of their time has been spent filling orders for the popular two-meter, single-sideband, horizontally polarized loops specifically designed for mobile operation.

To achieve more mobile gain from an omnidirectional antenna, you need to rob radiation that is wasted going straight up, and pull it down into the main lobe that you wish to hug the horizon. You can do this by stacking one loop on top of another, and feeding it with a 3/4 wavelength and 1/4 wavelength coaxial cable phasing harness with a T-connector. KB6KQ suggests separating his antennas 5/8 wave apart for two meters, working out to be around 48 inches. He supplies the optional stacking kit and phasing harness, all set to be wired up for increased signal strength while operating mobile.

We have a pair of polished KB6KQ superloops on our mobile communications unit, and they outperform any single loop dramatically when asked for comparative signal strength readouts. But they do look a bit strange — so plan to do some explaining when you stop your vehicle and begin DXing on the two-meter bands.

Well-known two-meter DXer, Chip Margelli, K7JA, well-known for his article on two-meter moonbounce (but only when the moon is full), has scored some older multi-element, two-meter, horizontal loops, and his system is one of the loudest on the air when compared to other single-loop systems. So, if ever you see an old mobile loop antenna in working order, snap it up, quick, because West and Margelli may be right behind you with bucks in hand!

If you are a new ham, we hope you'll consider joining the Weak Signal operators using single sideband and CW down at the bottom of each VHF and UHF band. And if you plan to do a lot of mobile operation, DO consider a good horizontal loop. Or if you are looking for a high-frequency system that works inside a confined attic, go with remote-controlled HF loops, and enjoy some good performance.

Write or call these different manufacturers, and see what they might set up for you when it comes to horizontal operation from compact loop antennas. NV

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New product News

PC CALLER ID PLUG

ITU Technologies introduces the new ITU PC Caller ID plug.

The unit decodes Caller ID data sent over a telephone line and delivers the name, number, date, and time to the computer. Enhanced services, such as voice mail notification and Caller ID w/call waiting, are also supported.

The PC Caller ID plug measures only 2.25" by 3" and can be plugged directly into any spare PC serial port and requires no external power.

Software with source code is included to transform a PC into an advanced Caller ID box and for integrating Caller ID into other applications. The software are DOS and Windows-based programs.

The unit is FCC part 68 certified and can also be used to supply Caller ID information to microcontrollers, single board computers, and other embedded systems.

The ITU PC Caller ID plug is available for only $34.95 plus $5.00 S/H.

For more information, contact:

ITU TECHNOLOGIES
3704 CHEVIOT AVE., STE. 3, DEPT. NV
CINCINNATI, OH 45211
513-661-7523 FAX: 513-661-7534
E-MAIL: sales@itutech.com WEB: http://www.itutech.com

FUZZY LOGIC ROBOT

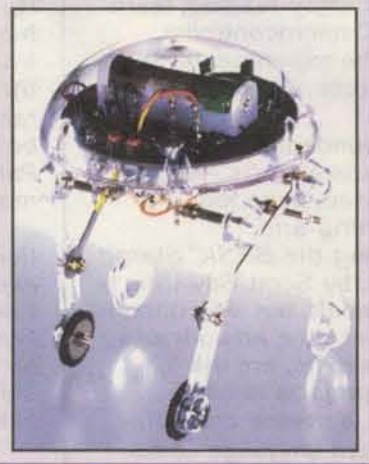
This limited edition WAO G robot challenges to dethrone the traditional method of control and problem solving.

Precision is expensive, especially when used for problem solving. Getting close is often good enough. Fuzzy logic exploits this "good enough" mentality through imprecision. By building and programming WAO G, you can set up membership functions and learn basic fuzzy control principles.

Fuzzy, fuzzy, fuzzy ... don't be 'fuzzy" with the new control methods that are being used in washing machines, vacuum cleaners, video camcorders, cameras, and automobiles.

Suggested selling price is $89.95.

NEW MOON WALKER



The New Moon Walker has combined the technology of two sensors – light and sound.

A whimsical indication of future trends, New Moon Walker begins to walk when it detects a change in light intensity or sound commands, and continues its four-legged voyage until instructed by an internal timer to stop. It challenges the builder at two levels of assembling experience – intermediate and advanced.

The suggested selling price is $34.95 (advanced experience), and $39.95 (intermediate experience).

For more information, contact:

OWI, INC.
1160 MAHALO PL., DEPT. NV
COMPTON, CA 90220-5443
310-638-4732 FAX: 310-638-8347

VELLEMAN HHS5

Velleman, Inc. announces the HHS5 handheld oscilloscope. The HHS5 is geared toward the hobbyist and priced at $200.00.

It is a factory assembled and tested, handheld LCD digital oscilloscope, featuring full auto setup, built-in fixed frequency sine and squarewave generator, readouts for volts AC peak, true RMS, DC and dB, and a computer interface with free software.

On-screen markers allow you to measure time and frequency. A tactile keyboard allows selection of trigger level, slope, trigger mode, Y position, volt/div., time/div., mode, and on-screen markers.

The unit is battery operated and features a built-in charging circuit.

It is suitable for audio repair, education, hobby, automotive, troubleshooting, etc.

For more information, contact:

VELLEMAN, INC.
7415 WHITEHALL ST., STE. 119, DEPT. NV
FT. WORTH, TX 76118
817-284-7785 FAX: 817-284-7712
E-MAIL: velleman@earthlink.net
WEB: http://www.velleman.be

ILM-216L LCD MODULE

The ILM-216L is an LCD module with a serial interface built in; no daughterboard required. It works like a terminal, receiving text via RS-232 at 1200 to 9600 baud (N81) and displaying it in large 5.9 mm characters on a supertwist, two-line by 16-character LCD.

Formatting text for the display is a matter of using familiar terminal-control characters such as carriage returns, line feeds, tabs, etc. Additional instructions control the backlight, position the cursor, define custom character, and read four switch contacts. The ILM-216L can even automatically right-align selected text – ideal for updating numeric fields with minimal programming overhead.

A unique feature of the ILM-216L is its non-volatile configuration memory (EEPROM). Users can set the ILM-216L to perform any of the following tasks at start-up: display a custom splash screen, define custom characters, and turn on the backlight.

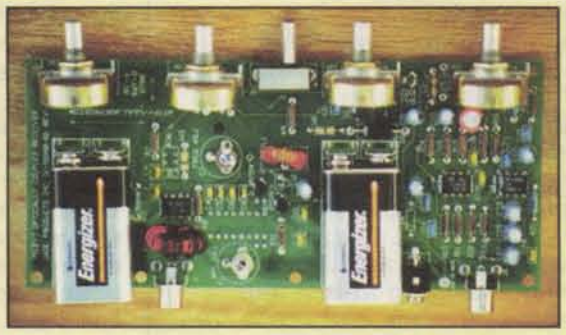
The ILM-216L draws only 5 mA with the backlight off; 40 mA with it on. At 80 by 50 mm, it fits into most standard 2x16 LCD mounting locations with a small overhand at the bottom.

Pricing for ILM-216L ranges from $49.00 (qty. 1) to $29.00 (qty. 100+).

For more information, contact:

SCOTT EDWARDS ELECTRONICS, INC.
P.O. BOX 160, DEPT. NV, SIERRA VISTA, AZ 85635
520-459-4802 FAX: 520-459-0623
E-MAIL: 72037.2612@compuserve.com WEB: www.seetron.com

OCR RECEIVER



Jade Products, Inc. announces their first all-mode (AM, CW, and SSB) 40-meter receiver.

This OCR is a high-performance regenerative receiver. A fiber-optics coupler in the front end allows smooth regeneration control, virtually no radiation, and excellent selectivity.

The OCR's stability is excellent for both SSB and RTTY reception and provides excellent SWL coverage of the AM activity in the 40-meter broadcast band.

The 6.6" x 3" circuit board has two ICs, a voltage regulator, FET, and the HP opto-coupler. Two nine-volt batteries power the entire receiver; one is used as bias for the front end and lasts practically as long as its shelf life. The other is the main power battery and draws 10 mA at high audio levels. This receiver makes an ideal portable unit.

Assembly is easy, taking the average builder about 2.5 hours. All parts necessary to build the kit are included, except for batteries. The receiver has four controls: audio, fine tuning, main tuning, and regeneration control. There is etch on the circuit board to build a muting circuit for those builders that want to use this receiver with a transmitter.

The kit costs $84.95 plus $7.00 S/H. For more information, contact:

JADE PRODUCTS, INC.
P.O. BOX 368, DEPT. NV, EAST HAMPSTEAD, NH 03826
1-800-JADEPRO FAX: 603-329-4499 E-MAIL: jadepro@jadeprod.com WEB: http://www.jadeprod.com/

reader FeedBack

Dear Nuts & Volts:

In late Sept. '97, I purchased a book, *Programming and Customizing the PIC Microcontroller*. The author is Myke Predko from Canada, and is published by McGraw-Hill.

I really enjoy reading, learning the PIC microcontroller, doing all the experiments, and some projects. An excellent book!

I am wondering if the new book in *Nuts & Volts Magazine*, July '98 issue, page four, *Programming and Customizing the BASIC Stamp Computer*, by Scott Edwards, is the same book, but re-written in BASIC? Since the artwork and cover are similar, are the 12 complete projects similar? Potentially, a person can compare different language codes and hardware.

Also, is Scott Edwards a founder of *Nuts & Volts Magazine*? On page four under the author's name there are two separate lines, separted by a comma. Normally, I (mentally) replace a comma with the word "and."

Would you be kind enough to inform me and/or your readers on these interesting books?

Bob K.

Response:

"Programming and Customizing the BASIC Stamp" by Scott Edwards and "Programming and Customizing the PIC Microcontroller" by Myke Predko are both part of the McGraw-Hill TAB (The Electronics Authority) series. For this reason, the covers are similar. Both books are available at Parallax.

The Predko book was released last year, and it's really an explanation of the Microchip PIC microcontroller. The book explains the many different types of PIC microcontrollers and hardware features, including interrupts, digital and serial I/O, and in-system programming. The book has eight projects and 31 experiments ranging from a keyboard interface and servo controller to register addressing and measurement of resistance values. The BASIC Stamp is mentioned on page three as an example of a popular single board computer-based on the PIC microcontroller, but other than a few paragraphs up front there's no other Stamp discussion.

The Edwards book is a "boot camp" for Stampers. It starts by covering the basics of connecting a Stamp to your PC, downloading a program, and hacking through electrical connections and simple circuitry. Projects include a robotic bug with whisker sensors, a traffic signal, a data-logging thermometer, and a short-range sonar. The back of the book has a CD-ROM with Parallax software and our manuals.

Architecture and applications of the BASIC Stamp are explained very well with the Edwards book, but with the Predko book you'll have a better idea of what's going on behind the scenes in the Stamp's PIC.

Scott Edwards is not a founder or owner of Nuts & Volts Magazine, but the original author of the Stamp Applications column. I'll send this letter to McGraw Hill so they replace the "," with the word "in" to read "by Scott Edwards, founder of Stamp Applications in Nuts & Volts Magazine."

The Stamp Applications column is now written by Jon Williams, an enthusiastic Stamper who works full time with water pumps and electronics.

Ken Gracey
Parallax, Inc.

Dear Nuts & Volts:

I was disappointed with Jeff Stefan's article "The Year 2000 Problem."

I thought *Nuts & Volts* might have cut through some of the hype and gotten down to the core of the problem. Not so, at least not yet.

I have 20+ years of experience in embedded system hardware and software design. My experience with packaging machines for french fries, corn chips, candy, etc., is that the date code is stamped on the plastic packing film with a special hot ink stamp. The date is set much the same way as one sets the date on the rubber stamps you get from the office supply store. Not much of a chance of a negative number. It doesn't seem likely to me that a manufacturer would ship mismarked packages.

In the building automation/energy management systems that I have been involved with, the computer works from a day-of-the-week clock. Usually a holiday or two are thrown in to allow for special on/off or open/close requirements. The actual year is not used except possibly for holidays dates. Getting stuck in an elevator at midnight Dec. 31,1999 seems no more likely than getting stuck because of a leap year or daylight savings time change.

Jeff Stefan said that "A lot of early real-time clocks store the year with two bytes, resulting in the year 2000 looking like year 00." Two bytes can hold an integer much larger than 2000. Some clock chips only tell you what the year is modulo 4, that is, will Feb. have 28 days or 29? Some chips may hold the year as two "nibbles" or two BCD digits, but I am not familiar with any that hold the year as two bytes that can only represent "year 00."

One last gripe. I believe there is a generally accepted difference between a real-time clock and a time-of-day clock. The real-time clocks I have used as part of real-time operating systems usually consist of an interrupt that occurs every few milliseconds. This interrupt is used by the operating system to help manage system resources and coordinate multiple software tasks. On the other hand, a time-of-day clock is more like a wrist watch. It tells you what time it is when you happen to look at it.

Let me offer a suggestion. Why not use *Nuts & Volts* to solicit actual examples of Y2K problems. If large sums of money are being spent fixing Y2K problems, surely some of your readers can share actual real world problems that they have seen or solved. You could compile and edit the results and print them in a later issue. Let's end some of the speculation and get down to the nitty gritty. The only real world problem I have heard of was that a friend of mine was going to pay for something over the phone with a credit card. He was told he could do that only if his credit card expiration date was not "00." Fortunately, he had a card that did not expire in 2000.

Herb Hainey, P.E.
Consulting Engineer

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Analog Input - 8 input pins. 12-bit plus sign self-calibrating ADC. Returns results in 1mV steps from 0 to 4095. Software programmable alarm trip-points for each input. DIP switch addressable; stack up to 16 modules on same port for 128 single-ended or 64 differential inputs. **$49**

Home Automation (X-10) - Connects between a TW523 and your serial port. Receive/transmit all X-10 commands with your home-brewed programs. Full collision detection with auto re-transmission. **$39**

Caller ID - Decodes the caller ID data and sends it to your serial port in a pre-formatted ascii character string. Example: *12/31 08:45 850-863-5723 Weeder, Terry <CR>*. Keep a log of all incoming calls. Block out unwanted callers to your BBS or other modem applications. **$35**

Touch-Tone Input - Decodes DTMF tones and sends them to your serial port. Keep a log of all outgoing calls. Use with the Caller ID kit for a complete in/out logging system. Send commands to the Home Automation and/or Digital I/O kits using a remote telephone. **$34**

50 MHz Freq Counter

Reads frequency from 1Hz to 50MHz and displays up to 7 digits on a 16 character LCD. Auto-range feature provides floating decimal point and automatic placement of suffix (Hz, KHz, or MHz). Microcontroller based provides for very small parts count. **$46**

DTMF Decoder/Logger

Keep track of all numbers dialed or entered from any phone on your line. Decodes all touch-tones and displays them on a 16 character LCD. Holds the last 240 digits in a non-volatile memory which can be scrolled through. Connect directly to radio receiver's speaker terminals for off-air decoding of repeater codes, or numbers dialed on a radio program. **$55**

IR Remote Control Receiver

Learns and responds to the data patterns emitted by standard infrared remote controls used by TVs, VCRs, Stereos, etc. Lets you control all your electronic projects with your TV remote. 7 individual output pins can be assigned to any button on your remote, and can be configured for either *toggle* or *momentary* action. **$32**

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Two modes of operation; either prevent receiving or placing telephone calls (or call prefixes) which have been entered into memory, or prevent those calls (or call prefixes) which have *not* been entered into memory. Use touch-tone phone to program.

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Block out selected incoming calls. Calls identified using Caller ID data. **$46**

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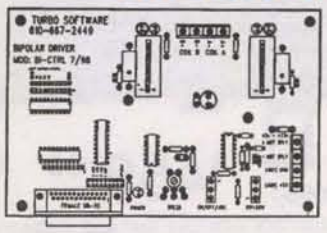

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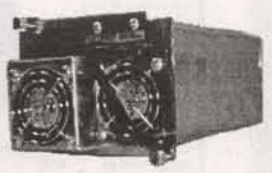

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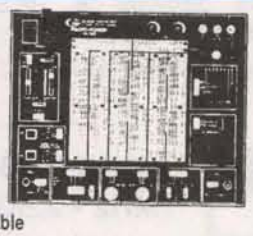

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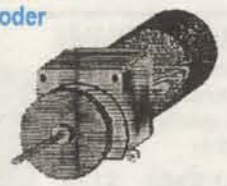

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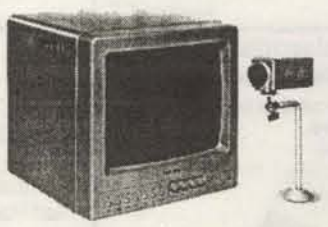

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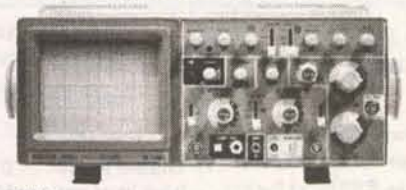

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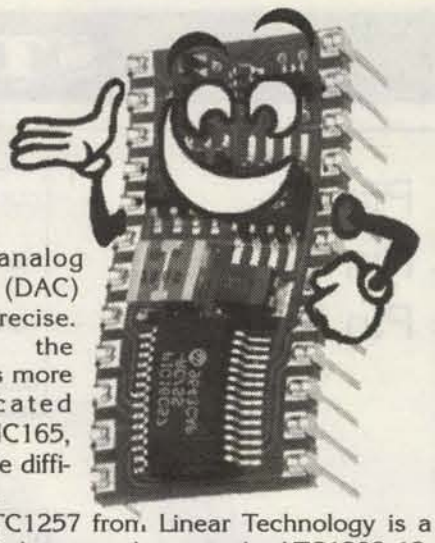
STAMP APPLICATIONS

by Jon Williams

Putting the Spotlight on BASIC Stamp Projects, Hints, and Tips



Complementary I/O

How many times have you been on the verge of finishing a very cool project only to "need" just one more input? Don't worry, it has happened to the best of us.

This month, we're going to take it kind of easy and look at a couple of serial-driven chips that can expand your project's I/O capabilities without a lot of code.

Gimme Them Bits!

In the last couple of issues, Robert Nansel in the Amateur Robotics Notebook column has been building a neat little BS1-controlled robotic platform. Included in the circuitry are three bumper switches. Well, how would you like to look at more bumper switches? Say ... six, seven, or even eight? It's no problem with the use of a $1.00 part.

The 74HC165 is a parallel-in, serial-out shift register that complements the 75HC595 (serial-in, parallel-out) that we've talked about in the past. And using the HC165 with the Stamp is brutally easy. Take a look at Listing 1. The inputs of the HC165 are loaded when the Parallel Load pin (Stamp pin 6) is pulsed low. What this means is that you'll get a snapshot of the inputs when you strobe this line. Even if the inputs change while you're moving the data into the Stamp, your "snapshot" data will remain intact.

With the inputs secure, they are moved into the Stamp through synchronous shifting. The first thing we do is shift our data byte left. This is accomplished by multiplying by two. The reason we must shift first is that we want the last bit clocked-in to reside in Bit0. If we shift after retrieving this bit, our data will not be correct. Then we grab the bit from Pin 1 and send a clock pulse to get the next bit.

Just a reminder for new Stamp programmers: bytes B0 and B1 are the only Stamp 1 variables that allow bit-level access. My habit is to reserve these two bytes when I'm designing my programs — just in case I need to do something with individual bits. For you robot builders (and others), the bits of B0 can be renamed SYMBOLically. You could, for example, give the bits names like FrLft, FrCntr, FrRt, RrLft, RrCntr, and RrRt. This will make your control code easier to read and debug.

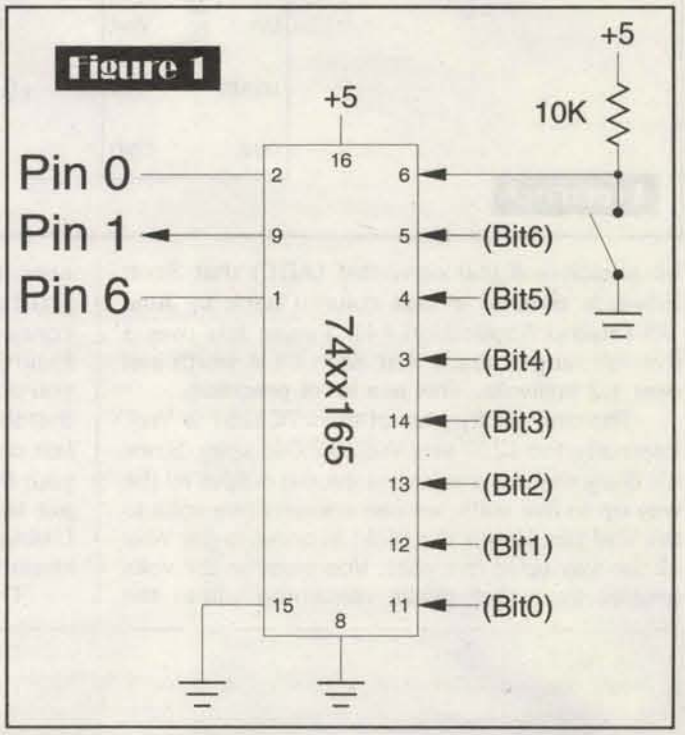
I've included code for the 75HC595 in the listing for your convenience. If you look closely you'll see that the code follows chip function: a mirror image of the 74HC165.

Precision Analog Output

Our next chip is an output device, a digital-to-analog converter (DAC) to be precise. While the LTC1257 is more sophisticated than the HC165, it's no more difficult to use.

The LTC1257 from Linear Technology is a 12-bit DAC that complements the LTC1298 12-

Figure 1



Listing 1

```
' Listing 1
' Stamp Applications: Nuts & Volts, September 1998

' -----[ Title ]-----------------------------------------------------
'
' File..... DIGIO.BAS
' Purpose... 74HC165/74HC595 Demo
' Author.... Jon Williams
' E-mail.... jonwms@aol.com
' WWW..... http://members.aol.com/jonwms
' Started... 02 AUG 98
' Updated... 02 AUG 98

' -----[ Program Description ]---------------------------------------
'
' Demonstrates digital I/O expansion using readily available shift
' registers.

' -----[ Revision History ]------------------------------------------
'
' 02 AUG 98 : Rev 1 complete

' -----[ Constants ]-------------------------------------------------
'
SYMBOL  Clk     = 0                     ' clock
SYMBOL  DPin    = 1                     ' data pin
SYMBOL  Data    = Pin1                  ' data bit
SYMBOL  _165    = 6                     ' HC165 strobe
SYMBOL  _595    = 7                     ' HC595 strobe

' -----[ Variables ]-------------------------------------------------
'
SYMBOL  temp    = B0                    ' using for shift in/out
SYMBOL  shift   = B2                    ' shift counter

' -----[ EEPROM Data ]-----------------------------------------------
'

' -----[ Initialization ]--------------------------------------------
'
Init:   Pins = %11000000        ' _595 & _165 = H, Clk = L
        Dirs = %11000001

' -----[ Main Code ]-------------------------------------------------
'
Main:   GOSUB DigIn                     ' get HC165 inputs
        DEBUG #%temp,cr                 ' display
        PAUSE 100
        GOTO Main
        END

' -----[ Subroutines ]-----------------------------------------------
'
DigIn:  PULSOUT _165, 5                 ' load the inputs
        INPUT DPin                      ' prepare for data in
        FOR shift = 1 TO 8              ' shift 8 bits
          temp = temp * 2               ' rotate left (MSB first)
          Bit0 = Data                   ' get a bit
          PULSOUT Clk, 5                ' clock out the next bit
        NEXT
        RETURN

DigOut: OUTPUT DPin                     ' prepare for data out
        FOR shift = 1 TO 8              ' shift 8 bits
          Data = Bit7                   ' MSB first
          PULSOUT Clk, 5                ' clock the bit
          temp = temp * 2               ' get next bit
        NEXT
        PULSOUT _595, 5                 ' bits -> outputs
        RETURN
```

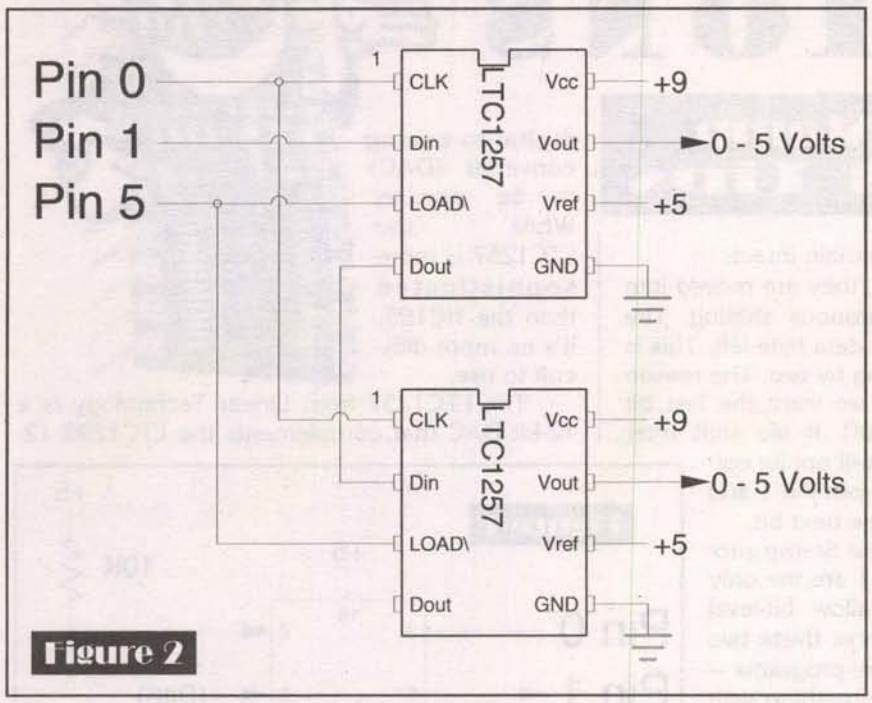


Figure 2

bit analog-to-digital converter (ADC) that Scott Edwards covered in this column back in June '95 (Stamp Application #4). Twelve bits over a five-volt range means that each bit is worth just over 1.2 millivolts. This is a lot of precision.

The only tricky part of the LTC1257 is Vref. Internally, the 1257 sets Vref to 2.048 volts. Since it's likely that we'd want to take out output all the way up to five volts, we can connect five volts to the Vref pin. Here's the trick: In order to get Vout all the way up to five volts, Vcc must be 2.7 volts greater than Vref (while remaining within the maximum parameters for Vcc). If you connect five volts to Vref and Vcc, you'll only be able to get 3.8 volts out of the DAC. This was an easy problem to solve. I simply connected my nine-volt, unregulated supply to the Vcc of the 1257. Presto, five volts out.

Listing 2 shows the code. Note the similarity to the HC595 code. The reason is that the LTC1257 contains a 12-bit shift register. Strobing the Load\ line causes the bits to be latched into the DAC section and the corresponding voltage appears on Vout.

In the event that you need more than one precision analog output, you can chain two or more 1257s together. Just connect Dout from one chip to Din of the next. Figure 2 shows the connections. Make sure that you output your "last" data first. What I mean is that the 1257 closest to the Stamp should be the last chip to which you send information. Once all your bits are shifted, pulse the strobe line to output the analog voltage. The second section of Listing 2 shows how to deal with two daisy-chained LTC1257s.

The LTC1257 is available from Digi-Key for a little over $8.00.

Help From The Real Experts

I've never claimed to be an expert at anything except getting into trouble with my soldering iron and a wild idea for a project. Thankfully, there are real experts among us, and two of my favorites have just released new books that are "must-haves" for any experimenter's bookshelf.

The first is *Programming And Customizing The BASIC Stamp Computer* (ISBN 0-07-913684-2) by well-known Stamp guru Scott Edwards. This book is — without a doubt — the most complete and comprehensive document ever published on using BASIC Stamps.

In addition to several projects, Scott's book covers electronic fundamentals, construction and experimentation practices, related circuits and calculations, and much, much more. If you're new to Stamps and electronics project building, GET THIS BOOK! And if you've been using Stamps for a while, GET THIS BOOK! It's really that good. The book comes with a CD with all the source code and tools you'll need to build the book's projects. The CD also includes all of Scott's "Stamp Applications" articles (1-29) from *Nuts & Volts Magazine.*

The next is *Serial Port Complete* (ISBN 0-9650819-2-3) by Jan Axelson. Jan has written for many technical publications and has been one of my favorites for a long time. During my recent move, I actually found in my desk one of Jan's articles that I'd clipped in 1990!

Serial Port Complete is an accurate title. This book covers everything you'd ever want to

Listing 2

```
' Listing 2
' Stamp Applications: Nuts & Volts, September 1998

' -----[ Title ]-----------------------------------------------------------
'

' File..... LTC1257.BAS
' Purpose... LTC1257 DAC Demo
' Author.... Jon Williams
' E-mail.... jonwms@aol.com
' WWW....... http://members.aol.com/jonwms
' Started... 02 AUG 98
' Updated... 02 AUG 98


' -----[ Program Description ]---------------------------------------------
'

' Demonstation program for the Linear Technologies LTC1257 12-bit DAC
' (digital to analog converter). Note that Vcc must be 2.7 volts greater
' than Vref in order to take the analog output all the way up to Vref.
' For conveniece, the 9v raw supply to the Stamp is used for Vcc while the
' regulated outpuIt from the Stamp is used for Vref.
'
' Vout = Vref / 4096 * dacValue
' Output resolution at 12 bits is 1.2 millivolts


' -----[ Revision History ]------------------------------------------------
'

' 02 AUG 98 : Rev 1 complete


' -----[ Constants ]-------------------------------------------------------
'

SYMBOL  Clk     = 0                     ' clock
SYMBOL  DPin    = 1                     ' data pin
SYMBOL  Data    = Pin1                  ' data bit
SYMBOL  _DAC    = 5                     ' LTC1257 Load\


' -----[ Variables ]-------------------------------------------------------
'

SYMBOL  temp    = W0                    ' using for shift in/out
SYMBOL  tempL   = B0
SYMBOL  tempH   = B1
SYMBOL  dac1    = W1                    ' output data
SYMBOL  dac2    = W2                    ' output data
SYMBOL  shift   = B6                    ' shift counter


' -----[ EEPROM Data ]-----------------------------------------------------
'


' -----[ Initialization ]--------------------------------------------------
'

Init:   Pins = %00100000
        Dirs = %00100011


' -----[ Main Code ]-------------------------------------------------------
'

Main:   dac1 = $07FF                    ' about half
        dac2 = $0FFF                    ' max output

        ' output to one DAC
        temp = dac1
        GOSUB AnOut
        PULSOUT _DAC, 5                 ' output the voltage

        END                             ' remove for two units

        ' output to multiple DACs
        temp = dac2                     ' last DAC first
        GOSUB AnOut
        temp = dac1                     ' closest DAC last
        GOSUB AnOut
        PULSOUT _DAC, 5                 ' output the voltage(s)

        END


' -----[ Subroutines ]-----------------------------------------------------
'

AnOut:  OUTPUT DPin                     ' prepare for output
        FOR shift = 1 TO 12             ' shift 12 bits
          Data = Bit11                  ' output the bit (MSB first)
          PULSOUT Clk, 5          ' clock bit into LTC1257
          temp = temp * 2               ' get next bit
        NEXT
        RETURN
```

know about serial ports and network projects. And it's not all theory. This is a very practical book, full of detailed examples — including Stamps and Visual Basic. No doubt some of you noticed that I've put off part three of the StampNet articles. I want to spend more time with *Serial Port Complete* before I wrap up that project.

Both books are professionally published and put together exceptionally well. Each contains detailed code listings, clear and concise diagrams, tables, and schematics. Let me reiterate: these books are "must-haves" for serious experimenters. And for you Web-shoppers, both books are available from Amazon.com.

Follow-Up On Past Projects

I recently moved back to the Dallas area and, boy, am I happy about that. Among the many cool things in the Dallas/Fort Worth metroplex is my favorite store, Tanner Electronics. You know that look of absolute glee that crosses a child's face when he enters a toy store? Well, that's how I look when I go into Tanner's.

Unless you live in the area, you've probably never heard of Jim Tanner or his store. So why do I bring it up? Two reasons: Jim regularly carries the SP0256-AL2 and 3.12 MHz crystals and will supply them to his friends at B.G. Micro if they run out. So those of you that were having trouble getting crystals for the voice project we did a few months ago, you can get them from B.G. — Jim promises me he will take care of the crystals for B.G. if they don't have them.

Jim's not fully prepped for mail order yet, but he will be soon. Stay tuned to Tanner's Web site at www.tannerelectronics.com for details.

Have fun and I'll see you next time. **NV**

SOURCES

For more information on the BASIC Stamp, contact:

Parallax, Inc.
3805 Atherton Road, #102
Rocklin, CA 95765
phone **(916) 624-8333**
Internet
http://www.parallaxinc.com

Digi-Key Corp.
701 Brooks Avenue South
Thief River Falls
MN 56701-2757
Phone: **800-344-4539**
or **218-681-6674**
Fax: **218-681-3380**

Jan Axelson
Lakeview Research
2209 Winnebago St.
Madison, WI 53704
Phone: **(608) 241-5824**
Fax: **(608) 241-5848**
jan@lvr.com

Scott Edwards Electronics, Inc.
2700 E. Fry Blvd. Suite A4
Sierra Vista, AZ 85635
phone **520-459-4802**
fax **520-459-0623**
www.seetron.com
info@seetron.com

Jon Williams
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Irving, TX 75062
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PS-1610 ($289.00) 16V/10A	PS-8300 ($199.95) 30V/3A
PS-8107 ($399.95) 30V/10A	PS-8301 ($259.95) 30V/5A

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PS-8203 ($549.95) 30V/5A/30V/5A

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• AG-2603AD ($229.95) with 6 digit counter
Function Generator • FG-2100A ($154.95) 0.2Hz-2MHz,5mV-20Vpp
• FG-2103 ($329.95) Sweep 0.5Hz-5MHz

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	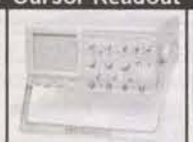					
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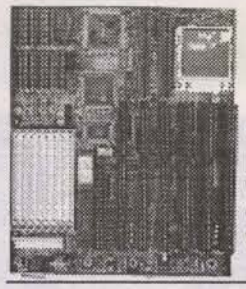

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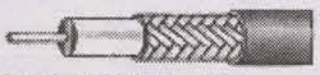

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Crystal controlled on 50.675 receive frequency. Superhet with 10.7MHz IF. Three ICs and one transistor. Not a kit! New, with schematics and spec sheet for major components.
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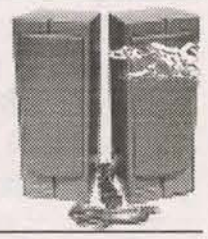

11.75"H x 4.5"W x 4.75"D. With RCA cables. Non-powered.
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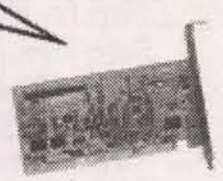
PLUG & PLAY IDE CD-ROM INTERFACE CARD



System requirements: IBM PC 386SX and higher or 100% compatibles; plug and play operating system (Windows 95), or a Configuration Manager driver (INTEL CM for WIN 31/DOS). or 100% PnP BIOS; 16-bit ISA bus slot. Supports up to two CD-ROM drives. Supports all ATAPI compliant IDE CD-ROM drives. No DMA support. 16-bit I/O polled CD-ROM interface external connector. Hardware settings: IDE Interface Interrupt (IRQ): 10, 11, 12, 14, 15; IDE Interface Port: Secondary, Tertiary, Quaternary (Note: all settings are PnP setable. More may be available). External Connectors: 16-bit I/O polled CD-ROM interface.
98C007 **Box of 20 for $19.95**

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This is a complex electronic device which requires the user to follow written programming instructions. We recommend that it be purchased only by those who have experience with similar devices..
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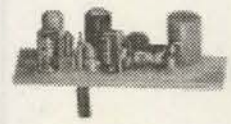

INFRARED KIT
Includes part #97V012 (assembled transmitter unit with forty-seven buttons), detector unit, printed circuit board, detector amplifier IC, and all parts needed to detect the signal from the transmitter and convert it to a serial TTL signal.
93V010 **$19.95 each**

UNIPOLAR STEPPER MOTOR DRIVER IC

UCN5804. Drives a unipolar stepper in one of three operating modes: single phase, two phase or half step. Up to 1.25 Amps per phase. Step and direction input. Drive with a 555 timer, parallel port, etc. Build your own robot, anything that requires precision positioning.
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93I003 **$7.95/set**

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Electret condenser type. This versatile microphone may be wired for handy-talkie, sound card, telephone, base station, aircraft radio, CB radio, motorcycle intercom, etc. An earphone or miniature speaker may be installed in either or both muffs. The microphone unit can be easily removed and installed on another headset or helmet.
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Events

CALENDAR

The Events Calendar is a free service limited to electronic events such as computer shows, hamfests, flea markets, etc. If your organization is sponsoring an event and would like a free listing, contact us at least 60 days prior to the event. Include your flyer, estimated attendance, name of the person to contact, and phone number.

Complimentary issues are available upon request for distribution to your attendees. A street address for UPS is required.

While we strive for accuracy in our calendar, we can not be responsible for errors or cancellations. The information contained in this column is for the use of the readers of *Nuts & Volts* and may not be republished in any form without the written permission of T & L Publications, Inc.

All listing information should be sent to:
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Events Calendar
430 Princeland Court
Corona, CA 91719
Phone 909-371-8497
Fax 909-371-3052
E-mail events@nutsvolts.com

SEPTEMBER 1998

SEPTEMBER 5

AL - SOUTH PELL CITY - Hamfest. National Guard Armory, 405 19th St. Gordon K. Porter KF4HBB, 205-338-7091.
E-Mail: k2@zebra.net
Web: http://www.qsl.net/k4scc/

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

CANADA - ONTARIO - CARP - Hamfest. Ottawa ARC, Jim Cummings VE3XJ, 613-446-1225.
E-Mail: fleamarket@oarc.net
Web: http://oarc.net/fleamarket

KY - CAVE CITY - Southern KY DX Assoc. Hamfest. Larry Brumett KN4IV, 502-651-2363.
E-Mail: lbrumett@glasgow-ky.com

SEPTEMBER 5-6

NC - SHELBY - Shelby ARC Hamfest. June Melvin WA4JNJ, 704-739-2583

SEPTEMBER 6

CA - LIVERMORE - Hamfest. Livermore ARK, Cliffe Kibbe KF6EII, 209-835-6715.
E-Mail: larkswap@hotmail.com

SEPTEMBER 11-12

AR - MENA - Hamfest. Queen Wilhelmina Assn., Charlotte Lee KC5DOR, 870-642-7656.
E-Mail: blee@alltel.net

MS - GREENVILLE - Hamfest. Greenville Repeater Assn. & Delta ARA, Paul S. Serio N5PS, 601-334-1500 or 601-332-7668

SEPTEMBER 12

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

IL - ROLLING MEADOWS - Convention & Banquet. Holiday Inn. Bill Smith W9VA, 847-945-1564. E-Mail: w9va@aol.com
Web: http://www.qth.com/w9dxcc

IN - SPENCER - Owen Co. ARA Hamfest. Kathryn Smith KB9INU, 812-829-2140

MN - WALKER - Hamfest. Cass Hubbard ARC, William Beebe, 218-547-3147.
E-Mail: billbb@eot.com

MO - COLUMBIA - Central MO Radio Assoc. Hamfest. Perry Ogletree N0NMC, 573-445-2662. E-Mail: cmra@qsl.net
Web: http://www.qsl.net/cmra

NC - MONROE - Hamfest. National Guard Armory. 8am-4pm. Talk-in: 145.39- & 444.425+. VE Exams. UCARS, Ron Lawrence KC4YOY, 704-289-1166. E-Mail: kc4yoy@trellis.net Peggy Knight N4MMM, 704-764-7279.
E-Mail: peggyg33@hotmail.com

NE - LEXINGTON - Amateur & Antique Radio Auction. National Guard Armory, 302 Washington. Randy Gigliotti 308-987-2312.
Web: http://hara.simplenet.com

NY - BALLSTON SPA - Hamfest. Saratoga Co. Fairgrounds. 7am-3pm. Darlene Lake N2XQG.
E-Mail: lake@capital.net

PA - ERIE - RA of Erie Hamfest. Matthew Steger N3NTJ, 814-835-1566 or 814-864-3809
E-Mail: n3ntj@erie.net
Web: http://www.erie.net/~n3ntj/hamfest.html

PA - SCHNECKSVILLE - Hamfest. Delaware-Lehigh ARC, Carl Seier AA3IX, 610-261-0403.
http://www.kutztown.edu/faculty/chuk/dlarc/

WV - WHEELING - Triple States RAC Hamfest. White Palace, Wheeling Park. 8am-3pm. William Maxwell WD8JIA, 304-242-2509.
E-Mail: BMAXWELL1@COMPUSERVE.COM

SEPTEMBER 12-13

FL - MELBOURNE - Platinum Coast ARC Hamfest. Joe Mitchell K4AW.
E-Mail: k4aw@digital.net
Web: http://www.ham.net/pcars/

SEPTEMBER 13

IL - JOLIET - Bolingbrook ARS Hamfest. Gary Hansen N9GH, 630-759-4955
Web: http://www.axnet.com/united/bars.htm

MD - GAITHERSBURG - Hamfest. Montgomery Co. Fairgrounds. Al Brown KZ3AB, 301-490-3188.
E-Mail: Amateur_Radio@hotmail.com
E-Mail: Al_Brown@ix.netcom.com

NJ - TRENTON - Delaware Valley Radio Assoc. Hamfest. Darryl Foyuth N2JVP, 609-882-2240

NY - BETHPAGE - Hudson Division Convention, Rob Todaro N2JIX, 718-763-5021 or 516-520-9311. E-Mail: mr_jix@pipeline.com
Web: http://arrlhudson.org

NY - HICKSVILLE - Long Island Mobile ARC Hamfest. Richie Selzer N2WJL, 516-520-9311.
E-Mail: n2wjl@juno.com

OH - FINDLAY - Hamfest. Findlay Radio Club, Dave Hoxworth AA8KJ, 419-423-3402.
E-Mail: dhoxworth@aol.com
Web: http://www.bright.net/~kanga/w8ft/

PA - BUTLER - Butler Co. ARA Hamfest. Gerald Wetzel W3DMB, 724-282-6777.
E-Mail: k311@nauticom.net
Web: http://home.sprynet.com/sprynet/n3ppz/

SEPTEMBER 19

AR - NORTH LITTLE ROCK - CAREN Hamfest. Dee Hooker KD5ASB, 501-791-0607.
E-Mail: kb5kit@flash.net

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

CA - SEBASTOPOL - Swapmeet. Holy Ghost Hall, 7960 Mill Station Rd. Colleen Dean KF6DHA, 707-578-4098. E-Mail: kf6dha@cdsl.net
Web: http://www.cdsl.net/scra

FL - SEMINOLE - Hamfest. Clearwater ARS, Paul Knupke Jr. KR4YL, 727-539-7429 xt. 66519.
E-Mail: pk@ij.net
Web: http://www.fgcarc.org/cars/tailgate.htm

GA - GAINESVILLE - Lanierland ARC Hamfest. Terry Jones K4FB, 770-967-6364.
E-Mail: K4FB@mindspring.com

KY - LOUISVILLE - Hamfest, Computer Show, & KY State Convention. KY Fair & Exposition Center. Herb Rowe W4WQD, 812-294-4905
E-Mail: WD4IXL@juno.com
Web: http://www.thepoint.net/~GLHA

MI - CALEDONIA - Hamfest. Grand Rapids ARA, Jim VanMalsen KB8QAQ, 616-887-8673 or 616-887-2937. E-Mail: barbv@voyager.net

MN - WARROAD - Banquet & Hamfest. Warroad Area Community Ctr., 222 Virginia Ave. N.E. William Landby W0DCM, 218-386-1654

NJ - MT. HOLLY - Hamfest. Mt. Holly Armory, Rt. 38. 8am-3pm. Joe Cramer N2XYZ, 609-268-2135.
E-Mail: n2xyz@juno.com or hamfest@SJRA.ORG

NY - HAMBURG - Western NY Section Conv. Harold Smith K2HC, 716-424-7184.
E-Mail: rochfst@frontiernet.net
E-Mail: info@buffalohamfest.org
Web: http://www.buffalohamfest.org

RI - FORESTDALE - Hamfest. RI Amateur FM Repeater Service, Rick Fairweather K1KYI, 401-725-7507. E-Mail: k1kyi@juno.com

TX - WICHITA FALLS - Hamfest. Wichita ARS, Dave Yonts KB5UOK, 940-692-8004
E-Mail: kb5uok@wf.quik.com
Web: http://www.wf.quik.com/wars

VT - RANDOLPH CENTER - Hamfest. Central VT ARC, Bill Kenefick AD1I, 802-685-2295

SEPTEMBER 19-20

AK - ANCHORAGE - State Convention. Kincaid Park Outdoor Center. Sat: 10am-5pm, Sun: 10am-3pm. Lillian Marvin NL7DL, 907-277-6741.
E-Mail: rlment@alaska.net

IL - PEORIA - Superfest. Exposition Gardens, Northmoor & University Streets. Jim Williams N9HHU, 309-692-FEST. Web: WWW.W9UVI.org
E-Mail: jimeoc@worldnet.att.net

NM - RIO RANCHO - NM State Conv. Richie Allen KC5NZR, 505-242-0208.
E-Mail: dchf@qsl.net Web: http://www.qsl.net/dchf

VA - VIRGINIA BEACH - Hamfest. Virginia Beach Pavilion, Art Thiemens AA4AT, 757-HAM-FEST.
E-Mail: hamfest@exis.net
E-Mail: artthiemens@juno.com
Web: http://www.vahamfest.com

SEPTEMBER 20

CT - NEWTOWN - Western CT Hamfest. Edmond Town Hall, Rt. 6. 9am-2pm. Ken Weith KD1DD, 203-743-9181.
Web: http://www.danbury.lib.ct.us/org/cara/

MA - CAMBRIDGE - Flea Market. Kendall Square area. MIT. Nick Alternbernd KA1MQX, 617-253-3776. Web: http://web.mit.edu/w1mx/www/swapfest.html

MI - ADRIAN - Hamfest. Lenawee County Fairgrounds. Brian KG8CO, 517-265-1537.
E-Mail: kg8co@lni.net
Web: http://www.lni.net/~w8tqe

MI - MT. CLEMENS - Hamfest. L'Anse Creuse High School. 8am-2pm. Richard Dzick N8MQU, 810-268-4671. E-Mail: n8mqu@aol.com

NJ - HAZLET - Hamfest. Veteran's Park, Greenacre Rd. Jack Petro KB2GJI, 732-681-5994.
E-Mail: jpkb2gju@aol.com

OH - CINCINNATI - GCARA Communications Expo. '98. Kolping Center, 10235 Mill Rd. Jim Weaver K8JE, 513-825-2868.
E-Mail: JimWeaver@aol.com
Web: http://w3.one.net/~rkuns/expo98/

PA - YORK - Hamfest. York ARC, John Shaffer W3SST, 717-764-4805. E-Mail: W3SST@Juno.com
Web: http://www.yorkhamfest.org

SEPTEMBER 25-26

AL - MOBILE - Hamfest. Mobile ARC, Tommy Thompson KC4OLV, 334-653-9239 or 334-431-3477. E-Mail: kc4olv@zebra.net

SEPTEMBER 25-26-27

OR - MILTON-FREEWATER - Hamfest. Walla Walla Valley ARC, Denise Hebel KC7ORO, 509-527-0411. E-Mail: dhebel@bmi.net

SEPTEMBER 26

AK - FAIRBANKS - Hamfest. Arctic ARC, Fred Brown KL7CUS, 907-452-3452.
E-Mail: fbrown@mosquitonet.com
Web: http://www.aarc.uaf.edu/

FL - DAYTONA BEACH - Hamfest. Embry Riddle

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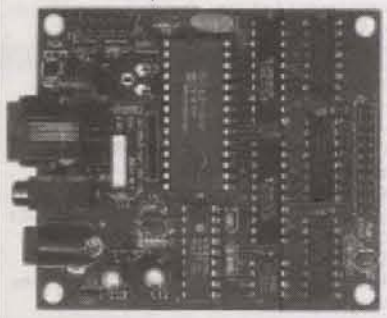

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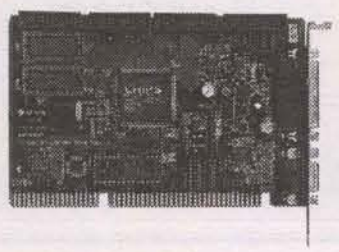

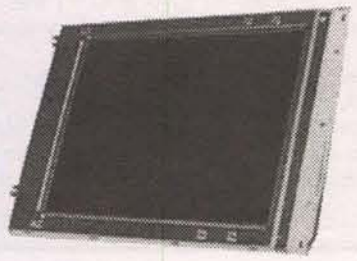

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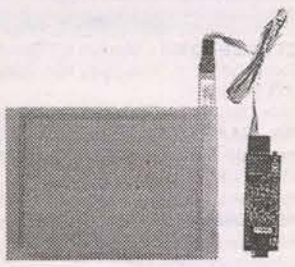

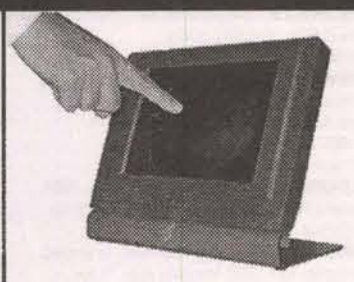

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Events CALENDAR

Aeronautical University Campus, Clyde Morris Blvd. 9am-5pm. John Munsey KB3GK, 904-677-8179. E-Mail: munseyj@worldnet.att.net Web: http://www.america.com/~dbara/

ME - LINCOLN - Hamfest. Ella Burr School. VE testing. Bagley Amateur Radio Club, Max Soucia 207-564-8943

NJ - HAMILTON TWP - Hamfest. Tall Cedars of Lebanon Picnic Grove, Sawmill Rd. 609-882-2240. Web: www.slac.com/w2zq

NY - HORSEHEADS - Hamfest and Computerfest. Chemung County Fairgrounds. 6am-3pm. Dave Lewis, 607-589-7495

SC - ANDERSON - Hamfest & Computer Fair. New Civic Ctr., 3027 Mall Rd. 9am-2pm. Talk-in: 146.79 or 146.97. Anderson Radio Club 864-964-9097 E-Mail: n4bao@carol.net

SD - HURON - Swapfest. Women's Bldg., State Fairgrounds. 8am-3pm. Lloyd Timperley WB0ULX, 605-352-7896 eves. E-Mail: wb0ulx@santel.net

VA - RUSTBURG - Hamfest. Central VA ARA, Cledus O. Neighbors KE4VVB, 804-239-5716. E-Mail: ke4vvb@lynchburg.net E-Mail: kd4awb@lynchburg.net

SEPTEMBER 26-27

IL - GRAYSLAKE - Radio Expo. Lake County Fairgrounds, Rts. 45 & 120. Sat: 8am-4pm, Sun: 8am-3pm. 708-457-0966. Web: http://www.chicagofmclub.org

NH - LANCASTER - Moose Swappers Hamfest. Russell Boyce N1YZE, 603-922-5514. E-Mail: cusvt@together.net

SEPTEMBER 27

CA - SANTA ANA - Swapmeet. ACP parking lot. Mary Russo 714-558-8813

CO - BOULDER - BARCs Swapfest. Boulder County Fairgrounds. 8am-2pm. BARC 303-380-6540. E-Mail: N0NLS@aol.com Web: http://www.thisistrue.com/barc.html

FL - NEW PORT RICHEY - Hamfest & Computer Show. 9am-3:30pm, Recreation Ctr. Chuck KU4EV, 813-937-2540. E-Mail: cfowler995@aol.com

IN - VALPARAISO - Hamfest. Porter Co. ARC, Larry Sargent KC9IU, 219-477-4214. E-Mail: lsargent@netnitco.net

NY - YONKERS - Flea Market. Lincoln High School. Kneeland Ave. 9am-3pm. Otto Supliski WB2SLQ. 914-969-1053

OH - BEREA - Hamfest. Cuyahoga Co. Fairgrounds. 6am-noon. 1-800-CLE-FEST. Web: info@hac.org

OH - SPRINGFIELD - Hamfest & Computer Show. Clark Co. Fairgrounds. 8am-3pm. Dave Ray KC8BVM, 937-325-3047

OCTOBER 1998

OCTOBER 2-3

MS - BILOXI - Hamfest. Point Cadet Plaza, Hwy. 90. Fri: 5-9pm, Sat: 8am-3pm. Talk-in: 146.730. VE Exams. MS Coast ARA, Larry Kiser KC5QFR, 228-463-0407. Doris Miller, 228-539-9929

NH - ROCHESTER - Hamfest. HOSSTRADERS, Joe Demaso K1RQG, 207-469-3492. E-Mail: klrgg@aol.com

OCTOBER 3

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

FL - ORLANDO - Hamfest. Bahia Shrine AR Unit, Phillip Stewart KD4CJK, 407-380-2902

IN - PERU - Hamfest. Miami Co. & Cass Co. ARCs, Gary Donaldson N9KQG, 219-382-2203. E-Mail: ccarc@netusa1.net Web: http://www.netusa1.net/~ccarc

NY - SYRACUSE - Hamfest. Pompey Hills Fire Dept., off Rt. 20. 8am-2pm. VE Exams. Talk-in: 147.90/30. RAGS, Vivian Douglas WA2PUU, 315-469-0590. Web: www.pagesz.net/~rags

PA - WARRINGTON - Mid-Atlantic States VHF Conference. Hampton Inn, 1500 Easton Rd. 9am-9pm. Mt. Airy VHF Radio Club (Packrats), John Sortor KB3XG, 610-878-5674. E-Mail: johnkb3xg@aol.com

SC - FT. MILL - Rock Hill Hamfest & Computer Fair. Knights Stadium, I-77 Exit 88. Talk-in: 147.03 -600. Pete Krenn KC4ZJ 803-366-5932. E-Mail: pete@cetlink.net

TX - BELTON - Ham Expo. Bell Co. Expo Center. Mike LeFan WA5EQQ, 254-773-3590. E-Mail: hamexpo@tarc.org Web: http://www.tarc.org

OCTOBER 4

CA - LIVERMORE - Hamfest. Livermore ARK, Cliff Kibbe KF6EII, 209-835-6715. E-Mail: larkswap@hotmail.com

IN - LAWRENCE COUNTY - Hamfest. Hoosier Hills Ham Club, John Scheiwe KB9LTI, 812-279-0050. E-Mail: jscheiwe@dmrtc.net Web: http://dmrtc.net/~jscheiwe/hamfest.html

MD - FRIENDSHIP - Hamfest. Columbia ARA, Richard Frank W9RZ, 410-531-2933 or 301-314-7806

NY - QUEENS - Hamfest. NY Hall of Science Parking Lot, Flushing Meadow Corona Park, 47-01 111th St. Stephen Greenbaum WB2KDG, 718-898-5599 night only. E-Mail: WB2KDG@bigfoot.com

PA - WARRINGTON - Hamarama. Bucks Co. Drive In, Rt. 611. Talk-in: 146.52 simplex. Mt. Airy VHF Radio Club (Packrats), Mark Schreiner NK8Q, 215-497-1414. E-Mail: nk8q@amsat.org

OCTOBER 10

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

FL - STARKE - Hamfest. ARC Bradford Area, Dan Phillips K4RVD, 352-475-2695

GA - AUGUSTA - Hamfest. Evans Middle School @ Washington & Belair Rd. 9am-4pm. Terry KE4MHN, 706-796-7635. E-Mail: ks4oc@bellsouth.net

GA - BLAIRSVILLE - Hamfest. GA Mountain ARC, Tom Lourigan WA4RBM, 706-745-1282. Web: http://www.stc.net/~jrv/

IN - VINCENNES - Hamfest. Old Post ARS, Doug Herrold KB9ONI, 812-882-4828. E-Mail: dherrold@abcs.com

WA - BREMERTON - Hamfest. North Kitsap ARC, Susan Johnson AB7MD, 360-697-9379. E-Mail: sujohnso@linknet.kitsap.lib.wa.us Web: http://www.silverlink.net/nkarc

OCTOBER 10-11

FL - TAMPA - Hamfest. Egypt Shrine Temple ARA, Jay Strom K9BSL, 813-822-9107

TN - MEMPHIS - MemFest '98. 2585 N. Hollywood @ I-240. Sat: 8:30am-4pm, Sun: 8:30-2pm. VE Exams. Talk-in: 146.22/146.82. Greater Memphis Amateur Radio Operators, Lee Bowers KA4KVW, 901-867-3461; Ben Troughton KU4AW, 901-372-8031

OCTOBER 11

CT - WALLINGFORD - Nutmeg Hamfest & Computer Show. Mountainside Special Event Facility. 9am-3pm. Gordon Barker K1BIY, 860-342-3258. E-Mail: nutmeghamfest@qsl.net Web: www.qsl.net/nutmeghamfest

MI - MASON - Hamfair. Ingham Co. Fairgrounds. 8am-1pm. Don Tillitson WB8NUS, 517-321-2004

NC - MAYSVILLE - Hamfest. Jo Ann Taylor WD4JYR, 252-393-2120

OH - LIMA - Hamfest. Northwest OH ARC, Greg Schwark N8WBD, 419-647-6321

OCTOBER 16-17

FL - STARKE - Hamfest. Bradford Area ARC, Lev Francis K4SRA, 352-473-3511. E-Mail: afn22489@afn.org

OCTOBER 16-17-18

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Events CALENDAR

CA - CONCORD - Hamfest. Pacific Division Convention, Dick Schulze AA6DL, 510-932-6125

OCTOBER 17

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
MT - BOZEMAN - Hamfest. Gallatin Ham RC, Steve Longacre AB7MV. E-Mail: longacre@montana.campus.mci.net
PA - LEWISBURG - Hamfest. Susquehanna Valley ARC, Bob Stahl WY3M, 717-473-7050
PA - PLEASANT HILL - Hamfest. Hanover Area Hamming Assn., Wayne Leister N3MTR, 410-857-0989
TN - GRAY - Hamfest. Kingsport, Bristol, Johnson City RCs. Tri-Cities Hamfest, POB 3682 CRS, Johnson City, TN 37601

OCTOBER 17-18

FL - WEST PALM BEACH - Hamfest. Palm Beach RA, Wayne Cunningham AD4AK, 407-697-4231

OCTOBER 18

MA - CAMBRIDGE - Flea Market. Kendall Square area. MIT. Nick Alternbernd KA1MQX, 617-253-3776. Web: http://web.mit.edu/w1mx/www/swapfest.html
MI - KALAMAZOO - Hamfest. County Fairgrounds. Talk-in: 147.040 K8KZO repeater. Kalamazoo ARC & S.W. MI AR Team, Gary Hazelton N8GH, 75075 M-40, Lawton, MI 49065. E-Mail: ka8blo@net-link.net Web: http://www.net-link.net/wmat
PA - GREENSBURG - Hamfest. Foothills ARC, Al Compton N3LQX, 724-523-3727. Web: http://www.geocities.com/Heartland/Acres/7896/
PA - SELLERSVILLE - Hamfest. Sellersville Fire House, Rt. 152. Linda Erdman KA3TJZ, 215-679-5764. Web: HTTP://WWW.RFHILL.AMPR.ORG
WA - CHEHALIS - Hamfest. Chehalis Valley ARS, James Kruger KK7AB, 360-748-1930

OCTOBER 23-24-25

OK - KINGSTON - Hamfest. Texoma Hamarama, Herb Sleeper WB5PHM, 940-855-5820. E-Mail: retmarine@cst.net Web: http://www.qsl.net/KC5SIG/HAMARAMA

OCTOBER 24

CANADA - QUEBEC - MONTREAL - Hamfest. Montreal South ARC, Francois Drien VE2FDA, 514-672-9994. E-Mail: ve2fda@amsat.org
NC - HICKORY - Hamfest & Computer Show. Catawba Valley Community College, 2550 Hwy 70 S.E. 8am-5pm. William B. Walker W4ZCV, 828-322-6180. E-Mail: N1PD@TWAVE.NET
OR - RICKREALL - Swap-Toberfest, Amateur Radio Emergency Services Convention. Polk County Fairgrounds. 9am-3:30pm. Talk-in 146.86 repeater. Mid-Valley ARES, Bob Boswell W7LOU, 503-623-2513. E-Mail: w7lou@goldcom.com Web: http://www.teleport.com/~n7ifj/swaptobe.htm
OR - SALEM - Hamfest. Mid-Valley ARES, Tami Burroughs KB7HEK, 503-585-5924. E-Mail: w7lou@goldcom.com Web: http://www.teleport.com/~n7ifj/swaptobe.htm
SC - SUMTER - Hamfest. Sumter County Exhibition Center, 700 W. Liberty St. 8am-3:30pm. Talk-in: 147.015. VE Exams. Sumter ARA, Steve Heriot KC4ZLB, 803-773-2282 or 803-428-5424. E-Mail: sheriot@ftc-i.net
WA - FERNDALE - Hamfest. Mount Baker ARC, Al Norton K7IEY, 360-354-4622

OCTOBER 24-25

TX - EL PASO - Hamfest. Int'l Hamfiesta Assn. Clay Emert K5TRW, 915-859-5502. E-Mail: cemert@dzn.com Web: http://www.dzn.com/hamfiesta

OCTOBER 25

IN - LEBANON - Boon/Clinton Co. Hamfest. Don Lecklitner K9DFK, 765-249-2020. E-Mail: nella@iquest.net
MD - WESTMINSTER - Mason-Dixon Hamfest & Computer Show. Carroll County Ag Center. Talk-in: CCARC repeater 145.410. VE Exams. Penn-Mar RC & Carroll Co. ARC, George Johns N3JKY, 717-633-6641. E-Mail: gjohns@sun-link.com Web: http://www.qis.net/~k3pzn
NY - LINDENHURST - Hamfest. Great South Bay ARC, Peter Portanova WB2OQQ, 516-541-4886. E-Mail: info@gsbarc.org Web: http://www.gsbarc.org
OH - MARION - HamFiesta & Computer Show. Marion County Fairgrounds Coliseum. 8am-3pm. Talk-in: 147.90/30 repeater. Marion ARC, Karen Eckard N8KE, 614-499-3565; Betty Krist N8UDT, 614-387-3533 after 5pm

OCTOBER 31

MN - ST. PAUL - Hamfest. Twin City FM Club, Dale Reak KB0VCV, 612-687-9535
MO - KIRKWOOD - Hamfest. SLARC & GARA, Dennis McCarthy AA0A, 314-351-3568 or 314-533-0321 xt. 12. E-Mail: mccartdj@slu.edu
TN - EAST RIDGE - Hamfest. Camp Jordon. 8am-4:30pm. Talk-in: 146.790- & 444.100+. Chattanooga ARC, Lou Carter KE4DGW, 423-821-4043. E-Mail: LCarter264@aol.com

NOVEMBER 1998

NOVEMBER 1

CA - LIVERMORE - Hamfest. Livermore ARK, Cliff Kibbe KF6EII, 209-835-6715. E-Mail: larkswap@hotmail.com
IA - DES MOINES - Hamfest. Tikva Tracers ARC, Randall Lees N0LMS, 515-279-4241. E-Mail: rclees@raccoon.com
OH - MASSILLON - Hamfest. Stark County Fairgrounds, 305 Wertz Ave. N.W. Talk-in: 147.18+ repeater. MARC, Don Wade W8DEA, 330-497-7232; Terry Russ, 330-837-3091 before 10pm. E-Mail: MARC.HAMCLUB@JUNO.COM

NOVEMBER 7

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
FL - SORRENTO - Hamfest. Lake ARA, Chuck Crittendon KA4EXM, 352-669-2075
KY - HAZARD - Swapfest. Hazard High School, south end of Rt. 15, Hazard Bypass. 8am-2pm. VEC Exams. Talk-in: 146.07/.67. KY Mountains ARC, John Farler K4AVX, 606-436-5354. E-Mail: jfarler@mis.net Web: http://www.geocities.com/SiliconValley/2564/kmarc.html
SC - MYRTLE BEACH - Beachfest '98. GSARC, Jim Wood KF4CJE, 843-238-0800. E-Mail: kf4cje@juno.com Web: www.w4gs.org

NOVEMBER 7-8

GA - LAWRENCEVILLE - Hamfest. Alford Memorial RC, Randy Bassett KR4NQ, 770-410-3989
TX - ODESSA - Hamfest. West TX ARC, Robert Jordan N5RKN, 915-335-7980. E-Mail: n5rkn@apex2000.net Web: http://www.apex2000.net/personal/wd5cwj/main2.htm

NOVEMBER 8

WI - KAUKAUNA - Hamfest. Fox Cities ARC, Chad Pennings N9PRC, 920-993-0485. Web: http://www.w9zl.ampr.org

NOVEMBER 14

AL - MONTGOMERY - Hamfest & Computer Show. Garrett Coliseum, S. AL State Fairgrounds. 9am-3pm. Phil 334-272-7980 after 5pm CST. E-Mail: wb4ozn@worldnet.att.net E-Mail: kf4ilp.arthur@worldnet.att.net Web: http://jschool.troyst.edu/~w4ap/
CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

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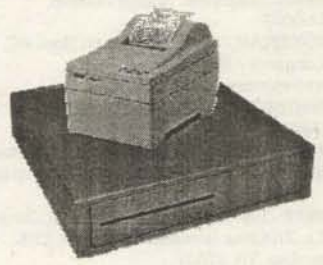

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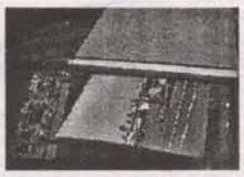

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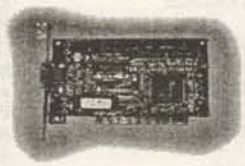

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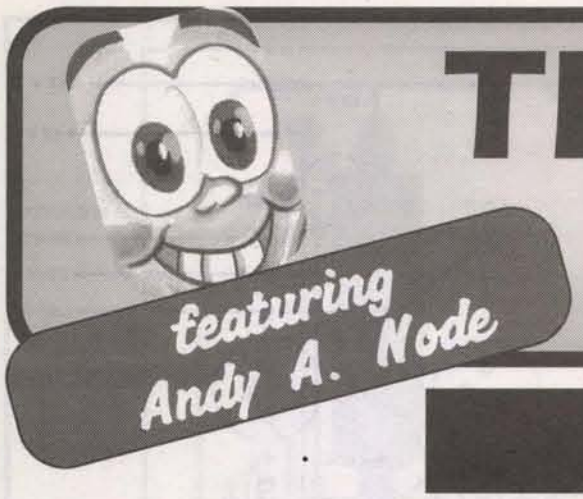


THE WEEKEND WORKBENCH

Andy Adds Watts To His Walkman

Single IC amplifier adds punch to your pocket pal

As I often do to clear my mind between projects, I went for a stroll through the park last week with a Walkman hitched to my belt. About halfway, the stroll turned into a trot and finally a gallop as I hurried back to the basement — an idea struck and I wanted to try it right away. However, my intended be-boop walk ended well before the Walkman tunes ran out, yet I didn't want to stay tethered to a pair of uncomfortable earphones just to hear the flip side of the Doors. Unfortunately, my bench amplifier was busy with other chores. Hence the inspiration for this month's project: a Walkman bench amplifier.

When I first considered the project, I set practical goals for the finished product. First, it had to be portable; nothing over a couple of pounds. Second, it had to be simple to construct — after all, I only had a weekend to put it together. And finally, the parts had to be readily available and not expensive. After searching through my catalogs, I decided that the LM1877 amplifier IC from National Semiconductor fit the bill perfectly (Figure 1).

The LM1877 is a 14-pin dual power amplifier that can shove up to four watts of stereo sound (two watts per channel) into a pair of eight-ohm speakers — that is, when it's powered from a 20-volt source. I decided to be less ambitious, and use a 12-volt source instead, which translates into about one watt per channel. It lightens the load by cutting the battery weight in half while sacrificing very little in the way of sound.

About now you're probably asking, "Andy, how can you say that a simple one-watt amplifier will boost the sound of my Walkman to make it sound like a boom box?" For one thing, I didn't say boom box ... but I did experiment, and the box does boom a lot. I added a loudness control (more of an acoustic thing than electronic) and put in a bass boost. Even two watts of power with a good bass end can rattle your windows ... and your neighbors.

Construction

Unlike most of my weekend projects — which I normally build and debug on a Radio Shack solderless breadboard (276-169) — this project demands a heavy-duty (one-ounce) printed circuit board. That's because the chip needs a heatsink, which the copper provides. You see, this IC is a quasi-complementary class AB amplifier, which means about 40 percent of the power it handles is wasted as heat (see "How It Works"). Instead of using a traditional heatsink, though, the heat goes through the middle six pins of the LM1877 (pins 3, 4, 5, 10, 11, and 12), where the copper foil gets rid of it.

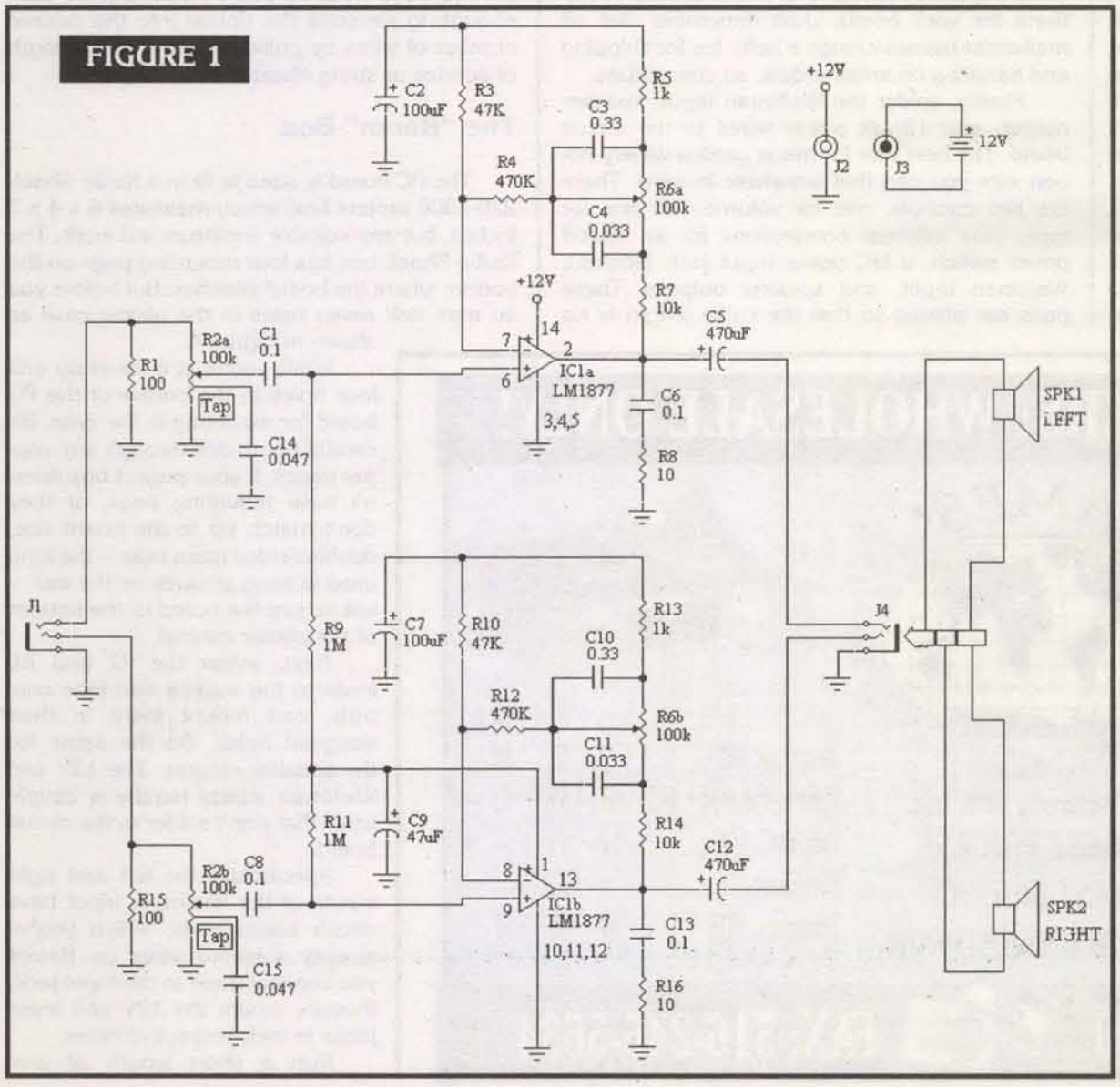
You can make the board yourself using the foil pattern shown in Figure 2, or buy it from Capitol Electronics (515-847-3888; http://www.capital-elec.com) for $12.50 plus $4.50 for shipping and handling. If you decide to make it yourself, I suggest you print out the file from our Web site (http://nutsvolts.com) under the name WALK_PCB.BMP, or make a photocopy of Figure 2 using an inkjet printer or commercial copier on a clear plastic transparency — the same kind used in overhead projectors. DON'T try this on a laser jet or thermal printer; it'll gum up the works!

Finally, transfer the artwork to a photosensitive PCB board, etch, and drill. Alternatively, both Techniques (908-788-8249) and DynaArt Designs (805-943-4746) sell iron-on "negative" making artwork that's worth looking into — moreover, it can be done on a laser printer as well as an inkjet.

The parts layout in Figure 3 shows the placement of the parts on the top side of the board — not the clad side. Simply put the right part in the right holes and solder it in place. You'll notice there's a jumper wire shown in Figure 3 that bridges pin 1 of IC1 to R11 and C9. Although it's simply a short piece of bare wire, make it the first part you put on the circuit board, followed by IC1 and the resistors. The electrolytics, which are bigger, should be the last items installed. Observe the orientation of IC1 and the electrolytic capacitors, C2, C5, C7, C9, and C12. Get them backwards and you'll likely burn them out.

If you buy capacitors C3, C4, C10, and C11 from Digi-Key (1-800-344-4539; http://www.digikey.com) or other large jobber, ignore the extra holes (C3b, C4b, C10b, and C11b). They're for Radio Shack parts only, and you won't see them on the schematic in Figure 1. As is too often the case with Radio Shack, they don't stock a full range of values of resistors or capacitors, like the 0.33uF or 0.033uF capacitors that are used for one-fourth the caps in the circuit. Fortunately, you

FIGURE 1



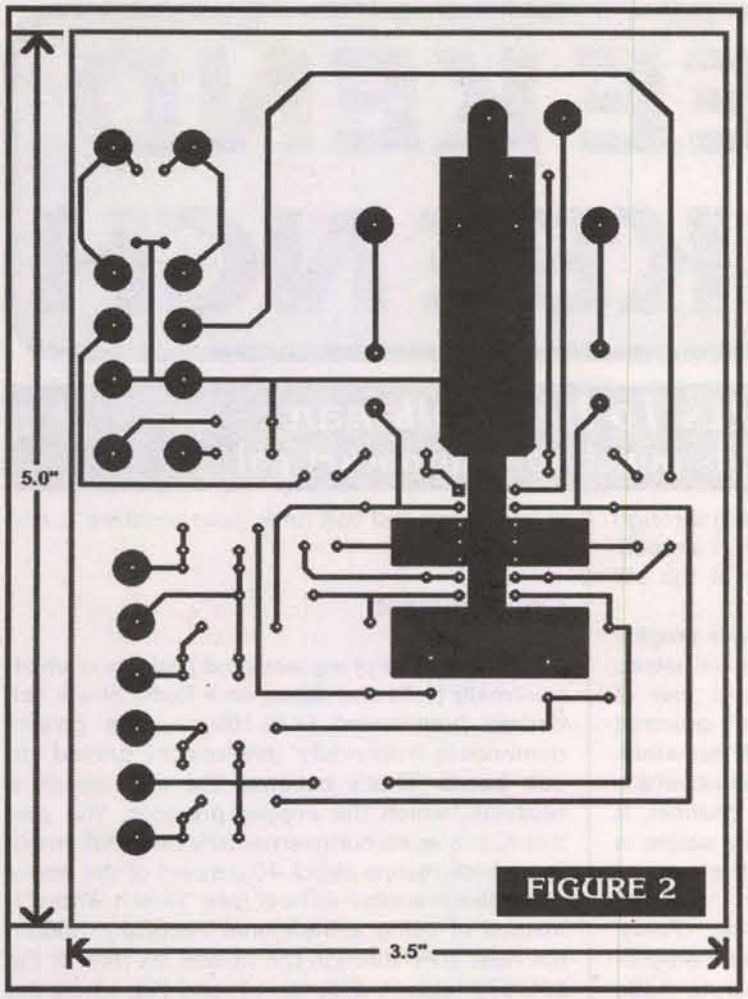


FIGURE 2

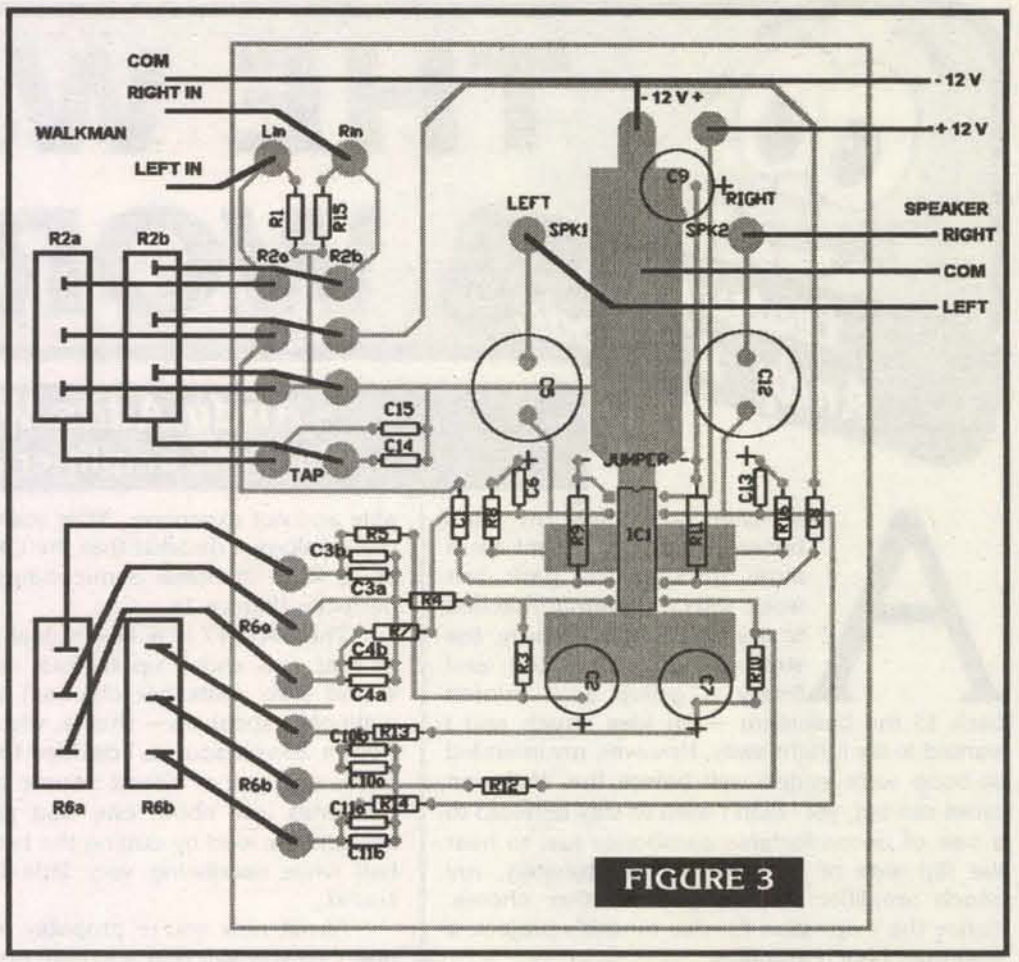


FIGURE 3

can parallel a 0.22uF capacitor with a 0.1uF capacitor (see parts list) to make a 0.32uF — which is close enough for our needs. Ditto for the 0.033uF, which is a combination of a 0.022uF and a 0.01uF capacitor.

However, there are plenty of other parts you can get from Digi-Key, so don't knock yourself out trying to make Radio Shack parts work. For example, Digi-Key sells the LM1877 chip for a low $2.28 and their capacitors are about half price. While Radio Shack will sell you an LM1877, too, they charge a whopping $10.99 for the same device — and it has to be special-ordered!

On the other hand, Digi-Key doesn't sell a dual, audio-taper potentiometer, which is used for both the loudness and bass boost controls, and they have a minimum order of $25.00, otherwise you're charged an extra $5.00 for handling.

Some of these parts can be located from other distributors, like All Electronics (1-800-826-5432; http://www.allcorp.com), for less if you don't mind shopping around and know how to make the right substitution. Check out our advertisers for your needs. Just remember that all mail-order houses charge a hefty fee for shipping and handling on small orders, so consolidate.

Finally, solder the Walkman input, speaker output, and 12-volt power wires to the circuit board. The best wire for this is garden-variety ribbon wire you can find anywhere in town. There are two controls, one for volume and one for tone, plus external connections for an on/off power switch, a DC power input jack (socket), Walkman input, and speaker outputs. These pads are placed so that the cable length is no longer than an inch between the board and any device.

The volume control has eight connections, two four-wire ribbons, the tone control uses two three-wire ribbons, and the Walkman input needs just one three-wire ribbon. The other three jacks have just two wires apiece. Fortunately, it's easy enough to separate the ribbon into the desired number of wires by pulling it apart like a length of licorice or string cheese.

The "Boom" Box

The PC board is sized to fit in a Radio Shack 270-1806 project box, which measures 6 x 4 x 2 inches, but any suitable enclosure will work. The Radio Shack box has four mounting pegs on the bottom where the board attaches. But before you do that, drill seven holes in the plastic case as shown in Figure 4.

While you're at it, carefully drill four holes in the corner of the PC board for mounting in the case. Be careful not to drill through any copper traces. If your project box doesn't have mounting pegs, or they don't match up to the board size, doubled-sided foam tape — the kind used to hang pictures on the wall — will secure the board to the bottom of the plastic cabinet.

Next, solder the R2 and R6 leads to the volume and tone controls, and mount them in their assigned holes. Do the same for the speaker outputs. The 12V and Walkman inputs require a couple wires that don't solder to the circuit board.

Specifically, the left and right inputs of the Walkman input have circuit board pads, which you've already soldered wires to. Before you connect them to the input jack, though, mount the 12V and input jacks in their respective holes.

Run a short length of wire

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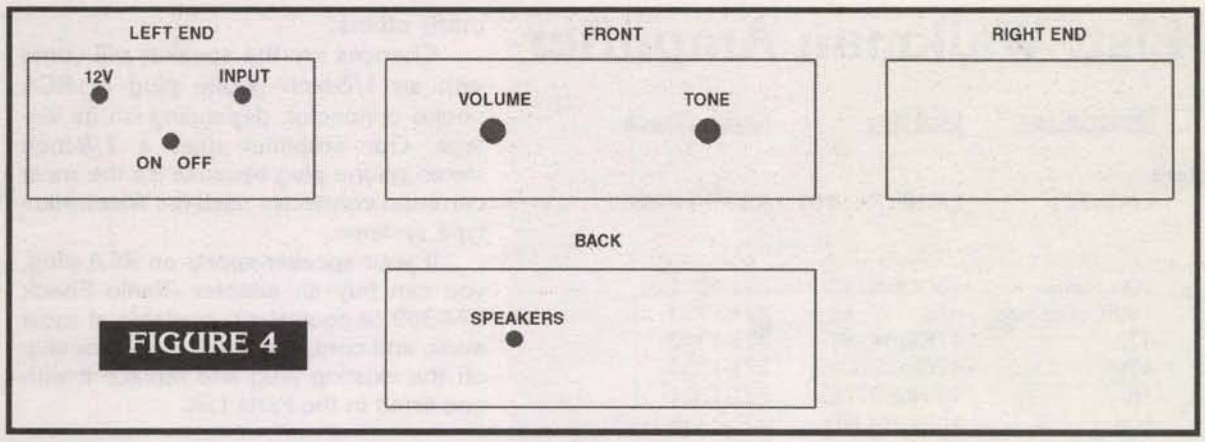

FIGURE 4

between the common of the Walkman input jack and the negative (outer shell) of the 12V jack, securing it mechanically so it doesn't fall out of the hole. Now secure the -12V wire from the circuit board to the outer shell connection and carefully solder the two wires. Apply just enough heat to make the connection; too much heat will melt the plastic.

Before mounting the on/off switch, solder the +12V wire from the circuit board to one side of the switch and another to the positive (inner pin) of the 12V jack. Mount the switch. The switch is a simple SPST (single-pole, single-throw) submini toggle switch, but its configuration isn't critical. A SPDT (single-pole, double-throw) switch works just as well, as is the case with the Digi-Key switch specified in the parts list. The only requirement is that the switch be of the on/off type and small enough to fit in the case — even a slide switch will work.

This completes the construction of the amplifier. Finally, put a lid on the box. You have a choice of an aluminum or plastic panel, so you decide. All it needs now is a Walkman, a power source, and a couple of speakers.

The Power Source

At first I toyed with the idea of putting the battery inside the case along with the circuit board and controls. However, that proved to be a futile quest because it means using a cabinet the size — and weight — of a brick. The alternative is a nine-volt transistor battery, which has a short life of just 30 minutes. Neither are acceptable. So I opted for an external power source, which can be either a battery or a DC wall adapter. That's the purpose of J2, the 12V jack.

If you choose to go the battery route, there are several options. The most logical is an eight-pack of AA alkaline cells, which can power the amplifier for up to 150 hours — depending on how loud and long you play it. That's the equivalent of 150 cassettes or CDs. The 270-407 battery holder from Radio Shack is my choice because you can attach it to the amplifier case using a Velcro strip or rubber bands, and it weighs just eight ounces. Larger cells, like C and

How It Works

The Walkman amplifier works on two levels. There's the gross circuit, which is built around a standard operational amplifier and includes the loudness and bass control circuits, and then there's the inner workings of the IC amplifier itself.

The basic design (we'll call it the gross circuit — with frills) is a non-inverting op amp with a frequency-selective feedback loop. The feedback loop, which has been simplified in Figure 5, consists of an RC (resistor-capacitor) network. The network consists of capacitors C3, C4, and R6 in what's called a bridge-T configuration, where the resistor is flanked by capacitors on both sides. Notice that the capacitance of C3 (0.33uF) is 10 times greater than C4 (0.033uF). Now, the time it takes to charge and discharge C3 is determined by the formula

$$t = RC$$

where t is in seconds, R in ohms, and C in farads (1,000,000uF). R6, while a fixed value, is a potentiometer which has a wiper that sweeps from one capacitance extreme to the other, and any value in between. To make a long story short, when the wiper is closest to C4, the low frequencies have a lesser path of resistance than when the wiper is closest to C3, where they're readily shunted to ground. Near mid-range, the frequency response is basically flat down to 60 Hz (Figure 5).

As you can see, the frequency peaks and valleys depend on a critical balance between all the components involved. Twist the knob one way, and you accent the high notes; twist it the other, and you have booming bass. There is no right or wrong setting, it's to each his own.

The other frequency-dependent part of the circuit is R2, the volume control. First off, R2 is an audio taper potentiometer where the resistance at the tap varies logrithmitically with the position of the wiper. At the low end, the resistance changes very little for a large rotation of the shaft. That's because our ears are more sensitive to sound changes when the sound is a whisper than it is to the difference between one jet engine or rock group. So, as the volume knob is advanced more and more to full volume, the faster the sound level rises.

Another thing happens as the sound level increases. When we hear a whisper, only the "intelligible" frequencies come through — those within the range of 1 KHz to 3 KHz. At this level (about 40 dB), bass notes in the range of 300 Hz are not audible. R2 is a special type of variable resistor that taps the resistance at about 40K at the lower end — the most sensitive end.

When the wiper is below this point, which amounts to about one-half the rotation, capacitor C14 shunts off much of the higher frequencies (as described above using the t = RC formula). Consequently, the lower (bass) frequencies are amplified more than the higher frequencies.

Once the wiper passes this tap, however, it has full access to both the high and low frequencies until the noise is unbearable. This is in contour with the sensitivity of the ear. Of course, once you pass 120 dB — concert level volume — wear ear plugs or expect to say "huh?" a lot as the sound pressure damages your hearing.

Resistor R1 loads the output of the Walkman to about the same level as it would be if the headphones were plugged in. This is needed to prevent damage to the Walkman or CD player. The output capacitor, C5, prevents the output transistors of the IC from shorting to ground and burning up, which leads us to the inner workings of the LM1877 chip.

The output stage of the LM1877 can be best described as a quasi-complementary amplifier with a directly-coupled driver stage (Figure 6). That lets us do two things. First, it allows the amplifier's electronics to run off a single-ended power supply — one that has a single positive source. The first op amps required what we call split supplies, where one power source was positive and the other was negative, as in +15V and -15V. This was quite popular in the '70s and into the early '90s. The LM1877 gets around the bipolar supply problem by internally biasing the driving transistors at 1/2 V+ (pin 14) — half the battery voltage. This causes the outputs — output 2 (pin 13) shown in Figure 7 — to stabilize at a voltage that's equal to halfway between V+ and ground — regardless of the actual value of V+. That is, the voltage of V+ (pin 14) can vary from six volts to 20 volts, and the bias circuit will always maintain a V+/2 bias.

But that's what we expect from most IC audio amplifiers today. Another thing we expect is thermal and short-circuit protection. That is, if the IC gets too hot because you turn up the volume too loud for too long, or the speaker wires short out, the chip simply shuts down until the potentially damaging condition(s) pass. The LM1877 has these features. This is why the LM1877 is a perfect choice for a Walkman amplifier.

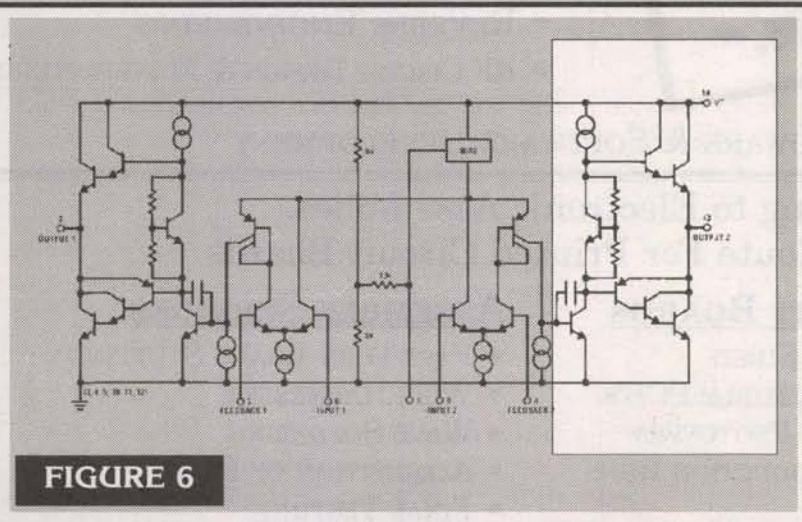

FIGURE 6

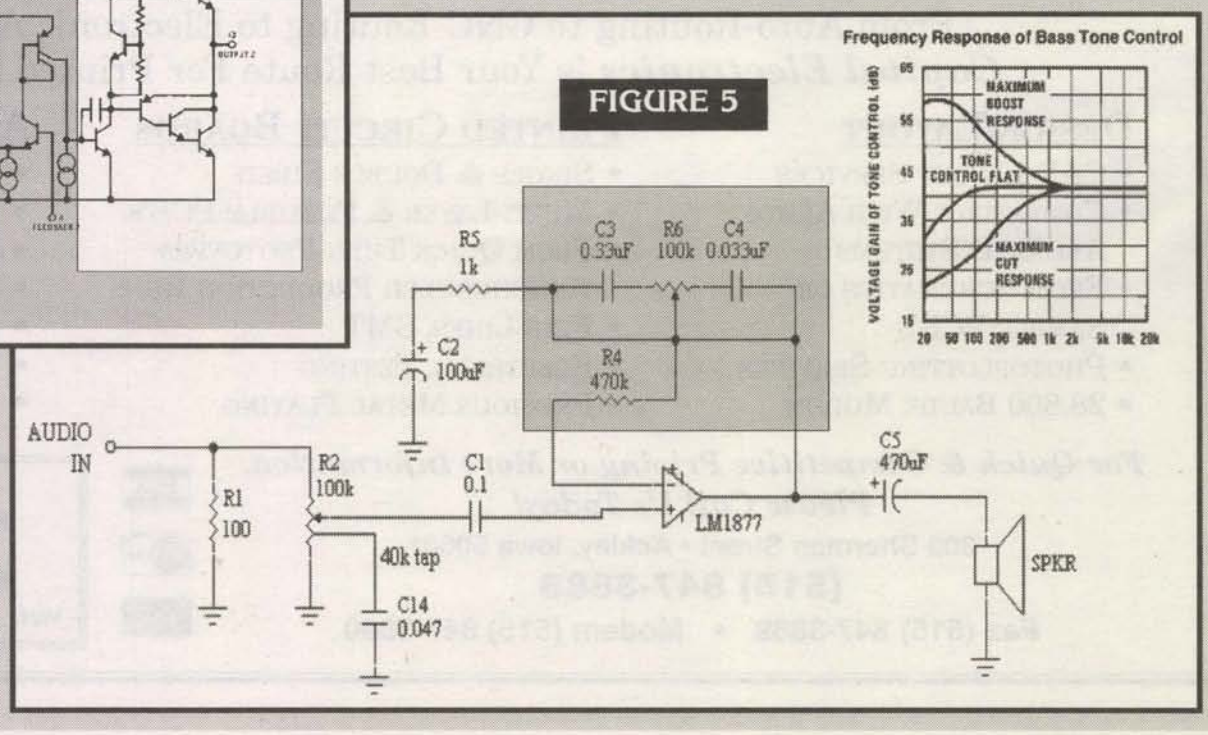

FIGURE 5

D, will power the amplifier far longer — 380 and 1,200 hours, respectively — but at the expense of size and weight.

That's why I used the jack that I did. It's a standard 5.5mm-by-2.1mm DC power jack that accepts a plug from most AC-to-DC wall adapters. The adapter you need is rated 12 volts DC at 500 mA (or a higher current) with a positive center (a negative center will smoke the amplifier, so pay attention). They range in price from a couple bucks on the surplus market to $13.00 if you shop at Radio Shack. Digi-Key sells it for $6.55. Regardless of what you pay, it's cheaper than replacing batteries in the long run — and a lot more convenient to use.

If you feel like experimenting, you can try RC power packs — the kind used with radio-controlled model cars, boats, and planes. They come in 12 volt, 9.6 volt, and 7.2 volt increments, and are rechargeable.

Boom, Boom, Boom, Boom ...

The final element is a pair of speakers. Just about any speaker will work, including the kind you often find at garage sales for $5.00 a pair. You can also buy them from Radio Shack, I recommend the 40-1400 or 40-1401 series ($9.99), or outlets like All Electronics, among many others.

Chances are the speaker will come with an 1/8-inch phone plug or RCA phono connector, depending on its vintage. Our amplifier uses a 1/8-inch stereo phone plug because it's the most common connector used for Watchman-type systems.

If your speaker sports an RCA plug, you can buy an adapter (Radio Shack 274-369 or equivalent, available at most audio and computer retail stores) or snip off the existing plug and replace it with one listed in the Parts List.

Parts List: Walkman Amplifier

Reference	Description	Digi-Key	Radio Shack
Semiconductors			
IC1	LM1877	LM1877N-9ND	RSU 11468881
Resistors			
R1,R15	100 ohms	100QBK-ND	271-1311
R2,R6	100K dual pot	n/a	271-1732
R3,R10	47K	47KQBK-ND	271-1342
R4,R12	470K	470KQBK-ND	271-1354
R5,R13	1K	1.0KQBK-ND	271-1321
R7,R14	10K	10KQBK-ND	271-1335
R8,R16	10 ohms	10QBK-ND	271-1301
R9,R11	1 MEG	1.0MQBK-ND	271-1356
Capacitors			
C1,C6,C8,C13	0.1uF	EF1104-ND	272-135
C2,C7	100uF	P5231-ND	272-1028
C3,C10	0.33uF	EF1334-ND	272-1069 & 272-1070
C4,C11	0.033uF	EF1333-ND	272-1065 & 272-1066
C5,C12	470uF	P5234-ND	272-957
C9	47uF	P5230-ND	272-1027
C14,C15	0.047uF	EF1473-ND	272-1068
Misc.			
S1	SPST switch	CKN1021-ND	275-634
Battery holder	see text		
J3 DC pwr plug	5.5mm x 2.1mm	CP-004A-ND	274-1569
J2 DC pwr jack	5.5mm x 2.1mm	CP-5-ND	274-1563
DC wall adapter	12V, 0.5A (opt)	T506-ND	273-1652
J1,J4	1/8" stereo jack	n/a	274-249
Spkr plug (opt)	1/8" phone plug	n/a	274-284
Cabinet	6 x 4 x2 in.	HM225-ND	270-1806

*Note: The above RSU 11468881 is a special-order item from Radio Shack Unlimited (**1-800-843-7422**).*

Getting It On

That's it! Plug in your Walkman, or whatever audio source you wish, with a suitable audio cable. This amplifier works with any device that has an earphone output jack, including a PC-based CD-ROM. Turn the volume control on the Walkman and amplifier all the way down, and plug in the speakers.

Finally, connect the battery, turn on the power, and enjoy.

The volume control is also a loudness control, so turn the volume up to a comfortable level and adjust the tone control until it sounds right. As the volume is increased or decreased, the bass will track the new volume setting and adjust the bass boost so that it remains more or less the same.

You can read more about this feature in "How It Works." 'Til next time when I tell you about what got me so excited to leave a leisurely stroll. **NV**

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Questions & Answers
TECH FORUM

This is a READER TO READER Column. All questions AND answers will be provided by *Nuts & Volts readers* and are intended to promote the exchange of ideas and provide assistance for solving problems of a technical nature. All questions submitted are subject to editing and will be published on a space available basis if deemed suitable to the publisher. All answers are submitted by readers and *NO GUARANTEES WHATSOEVER* are made by the publisher. The implementation of any answer printed in this column may require varying degrees of technical experience and should only be attempted by qualified individuals. Always use common sense and good judgement!

QUESTIONS

Send all material to **Nuts & Volts Magazine**, 430 Princeland Court, Corona, CA 91719, OR fax to (909) 371-3052, OR E-Mail to **forum@nutsvolts.com**

What are the most effective strategies for shielding EMI, especially in notebooks?

I have tried SSCGs to rescue peak emissions successfully. Are there any other low-cost methods?

9981 Chandra P. Dezoyss
Parkersburg, WV

Does anyone know how to modify a UPS "SAFE 250" model 5000-85022-01 to operate on 12 volts only?

9982 Robert Eshoo
Santa Monica, CA

Does anyone make a meter that measures the amount of salt in water?

9983 Alexander F. Miller
Weeki Wachee Acres, FL

I have a micro CCD camera and a 4" LCD video module part #205-050 from Parts Express. I want to use it for a rear monitor in a RV. How can I reverse the image without using a mirror or prism?

9984 Raymond J. Capton
Troy, MI

I use portable radios in my business and my range is not long enough. I need to know if there is a repeater that can be placed in my trucks to make the range longer. My work covers a 30 x 30 mile range.

9985 Charles Stokes
Seward, AK

I own four hard drives, but can only use two with the setup I have now ... does someone know or have the schematic to make my IDE hard drive into a parallel port hard drive?

9986 D. Gross
via Internet

Some of the yellow wood glues (i.e., Titebond) can be rapidly cured using a radio frequency. I once had a chance to briefly observe RF curing while visiting a kitchen cabinet factory. A small rectangular box was held against each joint for approximately five seconds. This stabilized the cabinet enough so that it could be moved down the assembly line without coming apart.

My guess is that this RF device produced a highly localized microwave heating effect that does not harm the wood or the operator.

Half-crazed woodworkers like myself would love to have such a device for our own shops. Since buying such an instrument would be cost prohibitive, I'm sure. Is there a circuit I could build?

9987 Daniel Katznelson
Willingboro, NJ

I need an integrated circuit or very tiny circuit (in physical size) which is telephone line powered and will record all touch-tones coming across the telephone line.

I would like to have a capacity, preferably of at least 50 10-digit telephone numbers. The circuit would be able to record numerical digits, as well as the "#" and the "*." Also, once the circuit (or IC) is disconnected from the telephone line, ideally the recorded touch-tone digits should remain in a non-volatile memory (until erased) or, if absolutely necessary, it should have an auxiliary tiny battery to hold the digits in memory.

Another device (also needed), when connected to it will "decode" the digits that have been recorded.

9988 Bob
St. Louis, MO

I have an early IBM (Green-Mono) monitor. I would like to know if I can use this monitor with a video B/W camera as a monitor, or with an older laptop computer as a monitor.

The IBM monitor has a male DB9 connector.

The laptop is a Packard Bell PB286NB with a mono display. The computer has an external video display connector.

9989 Bennie Belkoski
Vicksburg, MI

I recently purchased a scale model of the JPL Mars Rover. This item is available at most toy stores for about $20.00. (MFG. "Scientific Toys").

It is very well made for its price. For example, it has a version of the real rover's "trucked" wheel assembly!

The one change I immediately made was to replace the fake solar panel with real high-efficiency cells.

The model only goes forward and uses one motor with drive to both sets of wheels. It is geared heavily, so it goes over most small objects.

However, there is no easy way I see to make it steer. I would even settle for a "turn only in reverse" that some real cheap toy models have. Some real genius could even have feedback and/or on-board computer to provide some autonomy.

The rover has room for a small camera and or video transmitter. Can someone help me?

99810 Stephen Salgaller
Gardena, CA

I did a search for temperature and in the list was something referring to being able to 'sense' objects.

As luck would have it, what I would like to do is get some sensors (or perhaps build) to hook to my PC to warn me when someone is approaching my house. Perhaps indoors to tell me where people inside are.

99811 Nick Grenfell
via Internet

ANSWERS

ANSWER TO #89816 - AUG. 1998

The plasma displays that Dave Wood are looking for can be found at one of your *Nuts & Volts* regular advertisers. See the Repairs-Services heading (on page 70 of the August '98 issue, for example).

Contact: Marco Specialists, 5290-N Platt Springs Rd., Lexington, SC, 29073-9252. 803-957-5500, E-Mail: tilt@ix.netcom.com Web: http://pinballusa.com

Marco specializes in pinball machine repair parts, and carries an assortment of the gas plasma displays like Dave is looking for.

Kirk Ellis
Pikeville, NC

ANSWER TO #89814 - AUG. 1998

To keep most of the things off-the-shelf, I would buy one of those gasoline powered 120-volt emergency power plants.

They come in all sizes and capacities. You can then — employing an autotransformer — reduce the voltage to the appropriate level required for battery charging.

About lead-acid battery charging, I can recommend going to Unitrode Semiconductor's web page (www.unitrode.com) and search for battery chargers. The company produces all sorts of semiconductor solutions for battery charging, including some switch mode devices for high efficency.

Unitrode has also merged with Benchmarq Semi, which specializes solely in battery charging.

I would like to add a few words of caution. The voltage and current lev-

ANSWER INFO

- Include the question number that appears directly below the question you are responding to.
- Payment of $25.00 will be sent if your answer is printed.
- In most cases, only one answer per question will be printed.
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- Due to space limitations, we can not reprint the original questions with the answer. The question number and the issue it appeared in are printed above the answer.
- Unanswered questions from a past issue may still be responded to.
- Comments regarding answers printed in this column may be printed in the Reader Feedback section if space allows.

QUESTION INFO

TO BE CONSIDERED FOR PUBLICATION

All questions should relate to one or more of the following:
1) Circuit Design 3) Problem Solving
2) Electronic Theory 4) Other Similar Topics

INFORMATION/RESTRICTIONS

- No questions will be accepted that offer equipment for sale or equipment wanted to buy.
- Selected questions will be printed one time on a space available basis.
- Questions may be subject to editing.

HELPFUL HINTS

- Be brief but include all pertinent information. If no one knows what you're asking, you won't get any response (and we probably won't print it either).
- Write legibly (or type). If we can't read it, we'll throw it away.
- Include your Name, Address and Phone Number. Only your name will be published with the question, but we may need to contact you.

els you'll be working with can be quite dangerous. Although I don't think you would die from a 72-volt shock, the current levels at short circuit conditions can be extremely high, creating a burn or fire hazard.

Batteries may also explode, spewing nasty hot sulfuric acid.

Be very careful, always use redundant safety and cutoff devices, wear gloves and goggles, and insulate your tools.

Fernando Garcia
Brownsville, TX

ANSWER TO #8989 - AUG. 1998

You could use a standard dual H-bridge motor controller with the outputs connected to heavy duty (solid-state?) relays rated for continuous usage.

Amos Bieler
via Internet

ANSWER TO #8982 - AUG. 1998

TigerDirect (www.tigerdirect.com) seems to have a wide selection of affordable scanline converters that operate at or above 1024x768 resolution with even 16.2 million colors.

Amos Bieler
via Internet

ANSWER TO #8988 - AUG. 1998

The "right thing" to do when winding a coil depends on many factors such as complexity, interwinding capacitance, voltage breakdown, and unwanted coupling.

Winding from end-to-end and back again is bad for interwinding capacitance and voltage breakdown. The starting and ending turns have the highest voltage difference and they are next to each other.

Returning the winding to the starting point before winding the second layer reduces the voltage difference by two. Winding the coil in different banks is even better.

A progressive winding — where the layers are wound as the winding continues down the axis — is better still. But the cost of these techniques is more trouble winding the coil. If you don't need to do it, don't do it.

Breakdown voltage is not an issue in low-level circuits, and interwinding capacitance can often be compensated.

Winding from end-to-end and then back again does not cancel the first winding as long as turns surround the coil axis in the same direction. At any instant, we want the current flow in all the windings orbiting the axis in the same direction. The windings won't cancel as long as all turns circle the coil axis in the same direction.

Having said that, there is a parasitic current loop that is cancelled when a coil is wound back again. The loop is also cancelled if the ending wire is brought back to the starting position. For most coils, this parasitic loop is minor, because the inductance of the turns dominates the inductance of the parasitic traversing current.

Killing the parasitic loop is important for minimizing stray pickup in current transformers and Rogowski coils.

Gerald Roylance
Mountain View, CA

ANSWER TO #8983 - AUG. 1998

The quickest and easiest way to decrease the rotational speed of your output shaft is to go mechanical!

Gears are too costly and hard to install. Instead, use a pair of pulleys connected by a flexible belt.

In similar circumstances, I simply went to the local hardward store (but a toy-model supply store is also good) and found two coin-shaped disks. One was about twice the diameter of the other. Cost is less than $10.00.

Attach the smaller one on the motor's shaft, and the bigger one on a second shaft. Then, use a flexible belt (i.e., a rubber band or bungee cord) so that the smaller gear drives the bigger one.

Because the smaller gear has to go around twice just to get the bigger gear to go around once, you've decreased the speed by 2.

Thomas Ng
San Jose, CA

ANSWER TO #8985 - AUG. 1998

Richard is going about water speed measurement the wrong way. Measuring the RPM of the boats driveshaft gives you just that. The RPM of the drive shaft.

You cannot relate boat speed to shaft RPM due to the slippage of the prop in water, the pitch of the prop and the trim angle (angle the prop attacks the water) of the drive unit.

The most practical way to measure speed is by using a Pidot Tube and a speedometer calibrated for that tube.

Other less practical ways include using a GPS readout for start and end locations and a very accurate stopwatch for the run then doing time, speed, distance (TSD) calculations, or a surplus police radar gun.

By the way, a good way to measure the RPM of a shaft is to use the vehicle speed sensor (VSS) out of an '86 Chevy Caprice or an '89 Chevy Broughm.

The VSS is an infrared transmitter and IR receiver in a package. There are three wires to it: Battery ground, +12V in, and sig. out. The sig. out goes from 0 volts to more than 4 volts. (The one I played with went to 10 volts when the transmitted IR was reflected.)

A reflective strip on the shaft will reflect the IR signal into the receiver and cause an output pulse for every rotation of the shaft. You can buffer the output and drive anything you want with it. Even a Stamp.

Why would he want to measure speed to .01 KN anyway?

Chet Dera
via Internet

ANSWER TO #89815 - AUG. 1998

The key feature of the NE561 is a second multiplier for AM demodulation.

Roland Best's book, *Phase-Locked Loops*, does not offer any promising substitutes. I think the best you can do is use two chips: A PLL and a multiplier (such as an MC1496).

There are chips that include a second multiplier, but they usually have dedicated functions.

The NE567 has a second multiplier and may work for some tasks, but it is limited to 500 KHz.

Stereo decoders (e.g., CA3089) have two multipliers, but the PLL locks to twice the input frequency, so they are unsuitable for other applications.

By the way, although the NE561 works to 30 MHz, it isn't a good choice for many radio and synthesizer applications.

The VCO is a multivibrator, and multivibrators have a lot of phase noise. Radios and synthesizers need low phase noise, and that usually means linear oscillators with high Q resonators.

Gerald Roylance
Mountain View, CA

ANSWER TO #89812 - AUG. 1998

The LED 131 error message is reporting that the very first RAM chip tested is failing.

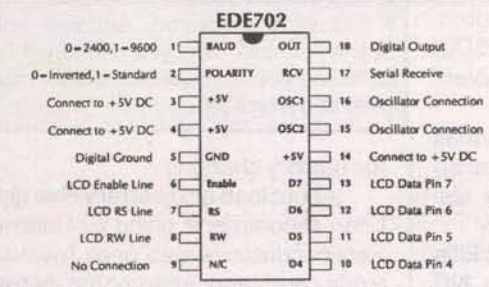
Before swapping around RAM chips, you should resolder all the molex pins on the PC boards (especially the ones leading to the power supply).

The solder joints on the pins often fail due to overheating and age. Use a 30W soldering iron and don't be stingy with the solder. The pins are large and can be hard to solder to.

The most likely reason the game is reporting this error is because the RAM chips are not receiving all the

Continued on page 36

Low Cost Serial to LCD Interface IC



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AMATEUR ROBOTICS NOTEBOOK

by Robert Nansel

Last month, I talked about alternatives to the BS1-IC for controlling a Breadbot. I eventually want to be able to do closed-loop control for wheel speed so Breadbot will stand a better chance of following the path programmed into it.

As it stands now, Breadbot's BS1 is too slow and has too little memory for really interesting robot programming. In evolutionary terms, the BS1-controlled Breadbot would rank somewhere around the level of a flatworm in terms of its computational horsepower.

The Great Brain Swap Caper

As I noted last month, it's easy to upgrade from the BASIC Stamp 1 to the BASIC Stamp 2. In this month's project, I'll show you how to convert Breadbot to run with a BS2. This should increase Breadbot's intelligence to be potentially on par, say, with the intelligence of an ant (writing the software to actually make Breadbot as smart as an ant is left as an exercise for the reader).

The BS2 runs twice as fast as the BS1 and has twice the I/O lines, eight times the program memory, as well as a more powerful instruction mix. For those of you shaky on soldering, though, one big plus is that it's already built. Plunk down your $49.00, build a $2.00 cable and you're all set. See my July '98 "Amateur Robotics Notebook" column in *Nuts & Volts* for details on building a BS2 programming cable.

You can use most of the existing Breadbot software and wiring without change. The wiring changes involve removing eight old jumpers and replacing those jumpers with 11 new ones; a procedure that took me about 10 minutes (Figure 2).

Assuming you built the Breadbot as shown in the first two articles in this series, you start by removing the BS1-IC, then the jumpers at the following locations: a-22—Vss, a-24—Vdd, e-27—f-27, e-28—f-28, g-23—g-27, c-30—c-51, d-31—d-52, and e-32—e-53.

Next, install new jumpers at: f-23—f-31, g-28—g-32, h-31—h-40, i-32—i-41, a-39—Vss, j-39—Vdd, d-52—f-52, e-53—f-53, h-45—h-51, i-46—i-52, and j-47—j-53.

Check your wiring against Figure 2 before you plug in the BS2-IC. Insert the batteries and plug the red lead into the Vdd bus. With a multitester or logic probe, test the whiskers and the front bumper for proper operation as follows:

Check that the voltage between the whiskers and the positive bus is six volts. Next, measure the voltage at pull-up resistor test point tp-a (b-51). With no pressure applied to the left whisker, the voltage should be near six volts.

Measure again while pressing the whisker back; it should now measure near zero volts. If either of these tests fail, check your wiring against Figure 2.

Repeat these tests at test points tp-b and tp-c for the front bumper and right whisker, respectively.

Check for the presence of 6V at j-39 and ground at a-39. Pull the +6V lead out, then install the Stamp with pin 1 at c-36 and pin 13 at g-47; the larger of the surface mount components should be oriented toward the front the of the robot (the bottom in Figure 2). If it isn't, you've got the Stamp plugged in backwards.

Once you're satisfied everything is right, plug the red battery wire back in and check the voltage levels at j-39 and a-39. If these voltages change drastically from your earlier measurement, or if any of the chips on the BASIC Stamp get hot, remove power immediately and recheck your wiring.

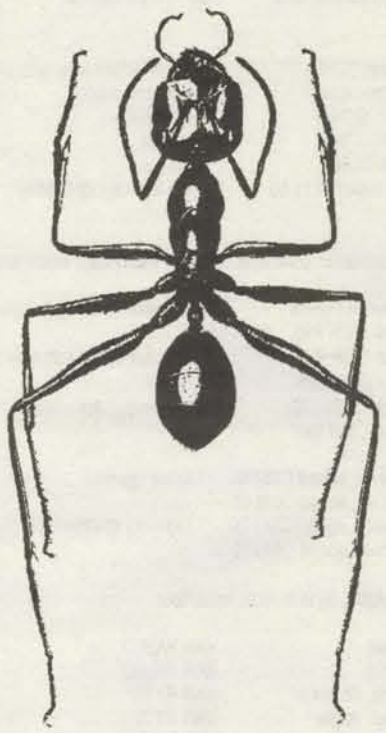
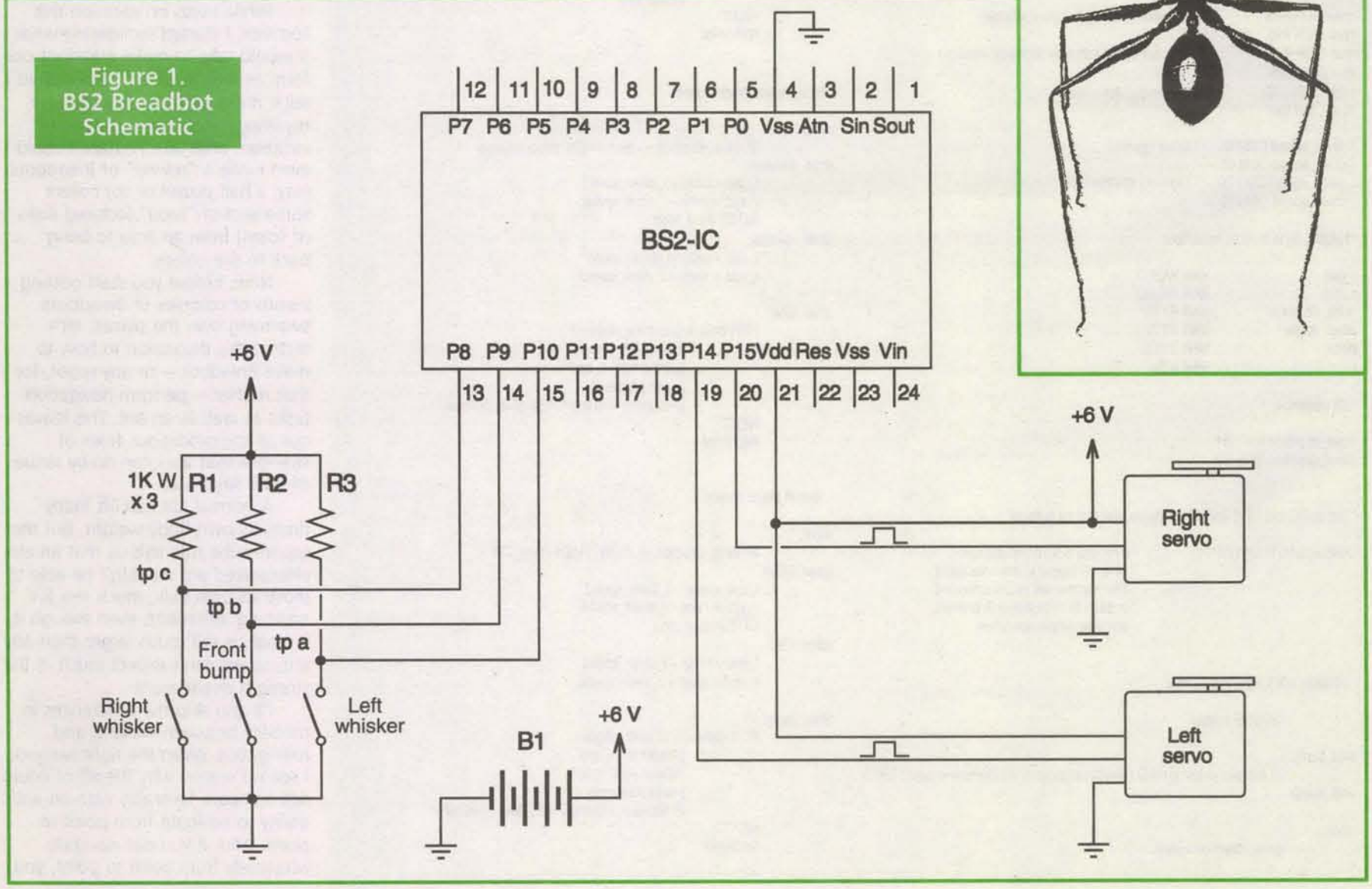


Figure 1.
BS2 Breadbot
Schematic



Let the Programming Begin

The software changes are also minimal. Listing 1 (TESTBB2.BAS) is functionally equivalent to TESTROBT.BAS from the second article. The changes that I made reflect the syntax differences between the BS1 and the BS2 versions of PBASIC.

First of all, BS2 PBASIC doesn't use the SYMBOL directive. Instead, all of the variables and constants must be declared with VAR and CON directives. Variables must be defined as BIT, NIB, BYTE, or WORD.

For sake of efficiency, I took advantage of the nybble variable type for the loop index 'i' used in the square subroutine. The BS2 STAMP2 software automatically allocates space as needed for bit, nybble, byte, and word variables without the need to specify the actual absolute address of each variable. This certainly saves time and hassle when you are programming.

The second change concerns how the I/O pins are declared. An output pin can simply be declared as a constant corresponding to the I/O pin, a number between 0 and 15. As the schematic shows, the right servo is now connected to I/O P15, and the left servo is connected to I/O P14.

The input lines for the bumper and whisker switches, however, are treated as bit variables with the predefined IN0 through IN15. For Breadbot, IN8 through IN10 are used for the three whisker switch inputs.

The third change to the software comes about because the BS2 PULSOUT command produces pulses with two-microsecond resolution versus the 10-microsecond resolution of the BS1. This means that all of the constants related to pulse widths must be multiplied by five in order to produce the same pulse durations to the servos.

A consequence of this is that the speed variables l_spd and r_spd must be allocated as word variables instead of bytes. I made no attempt to use the increase time resolution to more finely tune the calibration constants rstop and lstop.

The real solution will be to close the servo loop by sensing wheel speeds, and I suspect that thermal and aging effects will cause the actual calibration point to drift, so there may not be much to be gained with more precise calibration, so I don't plan to pursue it. If you do try recalibrating, let me know how it works out.

The final change to the software was to remove all of the variable names from the NEXT statements since BS2's STAMP2 doesn't use them. Indeed, STAMP2 will give you an error message at compile time if you leave them in.

All told, it took me about an hour to convert the original TESTROBT.BAS program and get it to run on the BS2. Total time to swap Breadbot's brains: under two hours. Try *that* with assembly language.

```
'
'                    TESTBB2.BAS
'
'


' Outputs

right CON 15            ' p15 = right servo
left CON 14             ' p14 = left servo

' Inputs

lwhisker VAR in10       ' p10 = left whisker
fbumper VAR in9         ' p9  = front bumper
rwhisker VAR in8        ' p8  = right whisker

'
bump CON 0              ' Bumper & whiskers active low
CCW CON 0               ' Counterclockwise
CW  CON 1               ' Clockwise
fwd  CON 0              ' Forward
rvrs CON 1              ' Reverse
pauseval CON 50         ' ~500 microsecond delay


' Calibration constants. Must be individually determined for each servo

rmax CON 925            ' Max pulse widths (clockwise rotation)
lmax CON 895
rmin CON 425            ' Min pulse widths (counterclockwise rotation)
lmin CON 395
rstop CON 675           ' Servo stop pulse widths
lstop CON 645

r_drive_speed CON 55    ' Drive speeds
l_drive_speed CON 65
r_steer_speed CON 50    ' Steering speeds
l_steer_speed CON 50

' Nybble, Byte & Word variables

l_spd                   VAR WORD
r_spd                   VAR WORD
drive_distance          VAR BYTE
steer_angle             VAR BYTE
delta                   VAR BYTE
i                       VAR NIB

' Bit variables

drive_direction VAR BIT
steer_direction VAR BIT


' Set up I/O bits  8, 9 and 10 as inputs, the rest as outputs

DIRS = %1111100011111111        ' Only bits 8,9,10 (inputs) and
                                ' 14 & 15 (outputs) are connected.
                                ' The rest are left as unconnected
                                ' outputs to save power & prevent
                                ' possible erratic operation


' Initialize left & right speed vars

        GOSUB allstop

wait_bump:
        IF lwhisker<>bump AND rwhisker<>bump AND fbumper<>bump THEN
wait_bump

main:
        drive_direction = fwd

' do a 6", left-hand square

        drive_distance  = 27    ' 27 = approx 1 wheel rev
        steer_direction = CCW
        steer_angle = 13        ' 0.40 rev = approx 90 degree turn
        GOSUB square

' now do a right-hand square

        steer_direction = CW
        GOSUB square
        GOTO wait_bump
        END

allstop:
        l_spd = lstop
        r_spd = rstop
        RETURN

'
' Drive in a square pattern
'
square:
        FOR i = 1 to 4          ' do 4 motion segments
                GOSUB drive
                pause 500
                GOSUB steer
                pause 500
        NEXT
        RETURN

'
' Straight line drive routine
'
drive:
        IF drive_direction <> fwd  THEN  drive_reverse
drive_forward:
        l_spd = lstop + l_drive_speed
        r_spd = rstop - r_drive_speed
        GOTO drive_loop
drive_reverse:
        l_spd = lstop - l_drive_speed
        r_spd = rstop + r_drive_speed

drive_loop:
        FOR delta = 0 to drive_distance
                pulsout left, l_spd
                pulsout right, r_spd
                pause pauseval
                IF fbumper = bump THEN drive_reverse
        NEXT
        RETURN

'
' Turn in place routine
'
steer:
        IF steer_direction <> CCW  THEN steer_CW
steer_CCW:
        l_spd = lstop - l_steer_speed
        r_spd = rstop - r_steer_speed
        GOTO steer_loop
steer_CW:
        l_spd = lstop + l_steer_speed
        r_spd = rstop + r_steer_speed

steer_loop:
        FOR delta = 1 to steer_angle
                pulsout left, l_spd
                pulsout right, r_spd
                pause pauseval
                IF fbumper = bump THEN drive_reverse
        NEXT
        RETURN
```

Listing 1.

But is it as Smart as an Ant?

Even with the BS2 brain transplant, Breadbot is obviously still at the flatworm level of intelligence. After all, how could it be otherwise: it uses TESTBB2.BAS which is functionally the same software as we've been using all along.

While I was on vacation this summer, I started wondering what it would take to make Breadbot perform as well as an ant. How could I tell if it did perform as well? I let my imagination roam (I was on vacation, after all). Perhaps I could even make a "colony" of Breadbots (say, a half dozen or so) collect some sort of "food" (colored disks of foam) from an area to bring back to the colony.

Now, before you start getting visions of colonies of Breadbots swarming over the planet, let's restrict this discussion to how to make Breadbot — or any robot, for that matter — perform navigation tasks as well as an ant. This leaves out all the prodigious feats of strength that ants can do by virtue of their small size.

A normal ant can lift many times its own body weight, but the square-cube rule tells us that an elephant-sized ant wouldn't be able to move its own bulk, much less lift anything. Breadbot, even though it is small, is still much larger than any ant, so we can't expect much in the strength department.

I'll also skip the differences in mobility between walking and rolling. But, given the right sensors, I see no reason why Breadbot could not compare favorably with an ant's ability to navigate from point to point. And, if you can navigate accurately from point to point, you

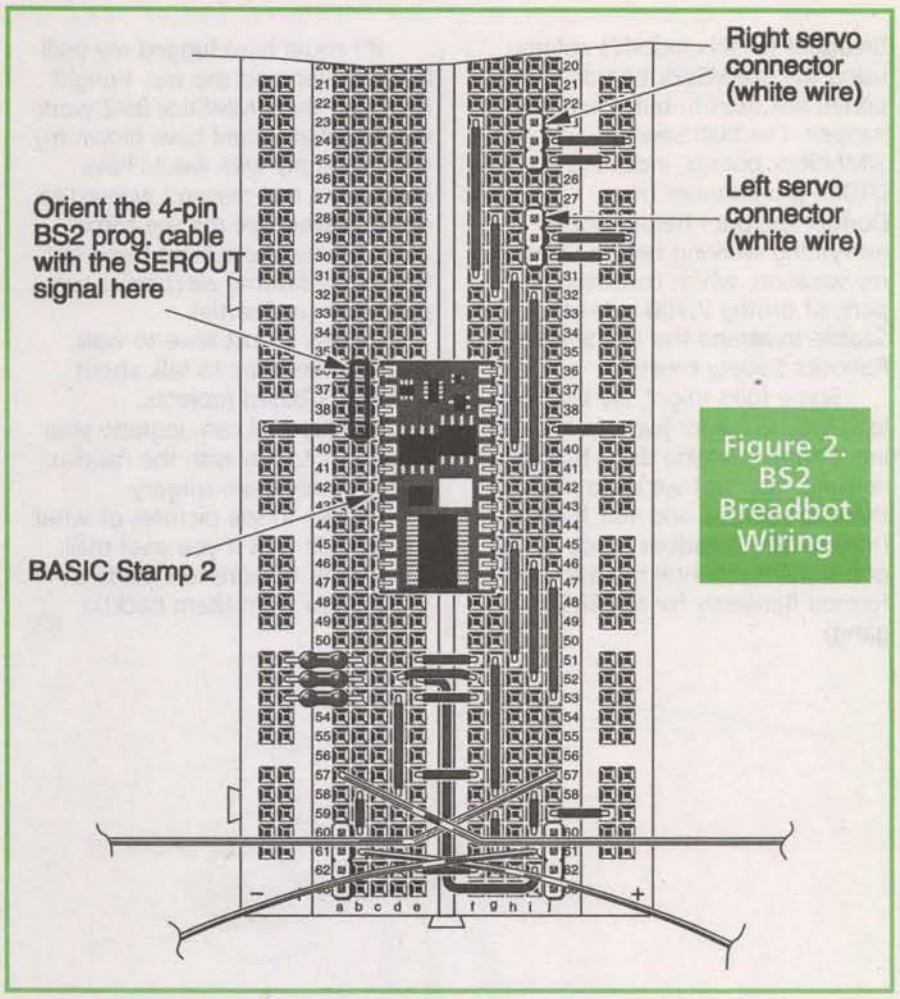


Figure 2. BS2 Breadbot Wiring

can find your way back to where you started.

How do you endow a robot with the ability to find its way home? For all animals (with the exception of barnacles, coral, sponges, and the like), this is a key survival issue, so it's no surprise that they've evolved many ways for solving this problem. They all boil down to a handful of basic strategies, listed below simplest first:

1) Follow a marked trail. Ordinary ants mark trails with pheromone secretions they detect with their antennae.

2) Dead reckoning, with or without landmark "beacons." Go in a particular direction at a certain speed for a certain amount of time. For bees, that's enough to get in the general vicinity of food. Since flowers look like bull's-eye targets in UV, once a bee gets in visual range of a flower it can home right in with a "simple" servo control algorithm.

3) Do landmark pattern recognition and world modeling. Plan paths according to this world model. Of course, this requires much more processing power than the first two, and correspondingly fewer animals use it (mostly mammals). In other words, I doubt you'd be able to shoehorn this one onto a BASIC Stamp.

Most robotics research has concentrated on scene recognition and world modeling like the mammals do, but most animals aren't mammals and don't have the neurons to spare, so we'll look only at the first two methods. What does nature tell us about the capabilities of trail followers and dead reckoners?

Ant colonies succeed with a simple food collection strategy: a lone foraging ant walks in a more or less random direction away from the colony and leaves a characteristic pheromone trail on the ground. When that ant finds a food source, it doubles back on its own trail, using its chemically-sensitive antennae to servo to the pheromone trail. If the ant's *left* antenna, say, detects a drop off of the chemical trail, that tells the ant's piloting algorithm to steer a little to the *right* until both antennae sense equal molecular concentrations.

When the ant brings food back to the colony, it communicates its find with other ants who then follow the trail the first ant blazed. Each ant on the trail automatically freshens the chemical trail. When the food source at the end of the trail finally is exhausted and the ants consequently stop freshening it up, the chemical trail evaporates. This evaporation is a good thing because if it didn't happen, the area surrounding the ant colony would quickly become a confusing jumble of old pathways that no longer lead to food.

The Little Lost Robot

It's not hard to think of ways that Breadbot could be modified to perform what amounts to line following. First you would need something to make marks on the ground, say, a felt-tip pen (assume Breadbot is running on a disposable paper surface). You also need a way to position the pen to leave marks on the running surface when you want (as when a Breadbot strikes out in a random direction in search of "food" or when it is "freshening up" an existing line) and lift the pen when you don't want marks (as when a Breadbot is following a fresh line it or another Breadbot has made). These marker lines would lead to food or back to the colony, depending on which direction you follow them. A marker strapped to an unmodified positioning servo would fill the bill.

Next, you need a way to reliably sense the marker line. A couple strategically-placed, downward-facing phototransistors would do fine for this, but cadmium sulfide cells would also work and would be a little easier to interface to a BASIC stamp using the POT command (for the BS1) or the RCTIME command (for the BS2). Throw in a few more sensors sensitive to the color of the "food" disks, and a gripper to grab the food ... hmmm ... this is getting complicated.

Okay, so anyway, the marking and the sensing are fairly straightforward. If you want your colony of Breadbots to keep running without getting confused by old path markings, you would probably want to use a so-called disappearing ink pen with a "decay" time in keeping with the speed of a Breadbot. The trick is to find an ink that disappears slow enough that several breadbots would have the chance to traverse a food trail before it disappears.

Other niceties would be to add inter-Breadbot communication links so one Breadbot can inform another when it has found a cache of food. Some kind of short-range RS232 IR link would seem appropriate here.

There's no guarantee that Breadbot could carry the weight of all the above hardware but, in principle it could be done. It would certainly make for a great exhibition or even a competition. All I have to do is build a dozen more Breadbots ...

It being vacation, I allowed this plan to slide to the back burner. Someday, maybe, but not in the next several months. Still, it got me to thinking about insect and robot navigation in general.

The Cataglyphis Convergence

Following pheromone trails is the way most ants navigate, but I've also read about Cataglyphis ants which live in the Saharan desert and use quite another strategy. In the heat of the Sahara, any pheromone trail an ant might leave as it searches for food will evaporate in minutes. To compound the problem, sources of food are scarce in the desert, so the average distance a foraging ant must travel is greater than in kindlier environments. What's a poor lost ant to do?

If you are a Cataglyphis ant you navigate using sky light. That's right, they use the second navigation

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method, dead reckoning.Cataglyphis is perhaps unique among ant species in that its members can sense the polarization angle of sky light. Though the sky looks pretty uniform to human vision, there is actually a distinct polarization pattern in the sky. Cataglyphis ants are especially sensitive to polarization in the UV spectrum present in sky light.

So, here we have a species of ants that operates rather more like bees than ants. Bees, since they fly, also cannot leave any kind of persistent trail for other bees to follow. They, too, navigate by sensing polarized light in the UV spectrum. The ants, like the bees, must communicate the relative bearing and distance of food to others at the colony, a more complicated problem than the simple "follow my trail to food" message that ordinary ants use.

What's more important, though is we have here a splendid example of evolutionary convergence. Two wildly different species (bees and Cataglyphis ants) use the same navigation method to gather food. They do so for the same fundamental reason, too, namely, they can't leave persistent trails for other members to follow. With the ants it's the heat, and with the bees it's air currents, but the result is the same: neither can leave persistent trails.

When nature converges to the same navigation solution through such radically different paths it is well for robot builders to pay attention. These creatures with so few neurons have succeeded and prospered over millions of years with such simple navigation techniques. Just as every animal doesn't have to be a big-brained mammal to get by, neither do all robots need vision and fancy world modeling.

As always, if you have suggestions for improving Breadbot, if you've built a Breadbot, or if you have questions or comments about amateur robotics topics, as usual you can reach me at:

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Pittsburgh, PA 15202
E-Mail:
bnansel@nauticom.net

Back to Reality

I wanted to build a Breadbot for this month's column using the SIMMStick boards I mentioned last month, but it just didn't happen. I've built several SIMMStick boards, including the DT001 programmer from Dontronics, but I hadn't gotten everything working before I began my vacation, which consisted, in part, of driving 2,700 miles to Seattle to attend the July Seattle Robotics Society meeting.

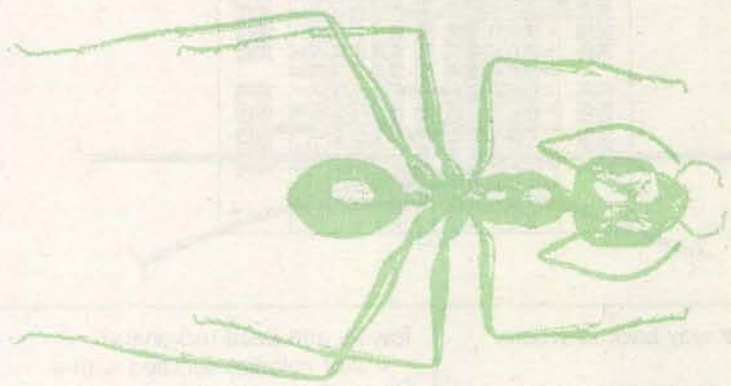
Some folks might say that's a long way to go for just one meeting. I know my wife did. I had to convince her that we were really there to sightsee and visit friends (meanwhile, Breadbot made its second transcontinental trip and performed flawlessly for the SRS gang).

If I could have lugged my oscilloscope along on the trip, I might have had the SIMMStick BS-2 working. But that would have blown my cover, and my wife would have known the real reason I wanted to go to Seattle. We did see some awful pretty places (and I also got to visit my favorite electronics surplus stores in Seattle).

I guess I'll just have to wait until another time to talk about SIMMStick-based projects. Meanwhile, y'all can upgrade your Breadbots to run with the Parallax BS2. It's only brain surgery.

I'd love to see pictures of what you've built (but if you snail mail me photos, be sure to include a SASE if you want them back!).

NV



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TEK CG5001-opt.01/TM5006 Programmable $6,000.00
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TEK AWG5102 Arb.Waveform Gen., ... $900.00
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WAVETEK 288 20 MHz Synthesized $750.00
Function Generator, GPIB

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BERKELEY NUCLEONICS 7085B Digital $750.00
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HP 214B-001 10 MHz Pulse Generator, ... $1,750.00
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HP 8015A 50 MHz Dual Output Pulse Generator $750.00
HP 8080A/81A/83A/84A 300 MHz Word Generator $800.00
HP 8080A/91A/92A/93A 1 GHz Single $950.00
Channel Pulse Generator
HP 8115A 50 MHz Dual Channel $3,500.00
Pulse Generator, HPIB
TEK PG502 250 MHz Pulse Generator, ... $600.00
Tr<1nS, TM500 series
TEK PG505 100 kHz Pulse Generator, ... $275.00
80 V peak, TM500 series
WAVETEK 802 50 MHz Pulse Generator $300.00

VOLTAGE & CURRENT

VOLTMETERS

FLUKE 845AR High Impedance Voltmeter / Null Detector $500.00
HP 3456A 6-1/2 Digit Voltmeter $750.00
HP 3478A 5-1/2 digit Multimeter, HPIB $700.00
KEITHLEY 181 6-1/2 digit Nanovoltmeter, ... $1,000.00
10 nV sensitivity, GPIB
SOLARTRON 7081 8-1/2 digit Voltmeter $3,900.00
TEK DM501A 4-1/2 digit Multimeter, ... $225.00
TM500 series plug-in

CALIBRATION

FLUKE 510A AC Reference Standard, ... $450.00
10 VRMS, 0-10 mA
FLUKE 515A Portable Calibrator, ... $1,000.00
DC/AC/Ohms, line & battery power
FLUKE 5220A Transconductance $3,000.00
Amplifier, DC-5 kHz, 0-20 A
FLUKE 720A 7-decade Kelvin-Varley Voltage Divider $1,250.00
FLUKE 731B DC Reference Standard $400.00
FLUKE 732A DC Voltage Standard $2,000.00
HOLT 11 AC Thermal Converter Set, ... $3,000.00
0.5-1200 V, 20 Hz-30 MHz
VALHALLA 2703 AC Volt.Std., ... $2,250.00
0-120V/10 Hz-100 kHz;120-1200V/10 Hz-1 kHz

VOLTAGE SOURCES

HP 6115A Precision Dual Range $850.00
Power Supply, 50V 0.8A / 100V 0.4A
KEITHLEY 228 Programmable Voltage/Current Source $2,500.00

CURRENT METERS & SOURCES

HP 4140B Picoammeter / $2,000.00
DC Voltage Source, without test fixture
HP 6177C DC Current Source, to 50V, 500mA $500.00
HP 6181C DC Current Source, to 100 V, 250 mA $500.00
HP 6186C DC Current Source, to 300V, 100mA $750.00
KEITHLEY 225 Current Source, ... $500.00
0.1 uA-100 mA, 10-100 V compliance
KEITHLEY 227 Current Source, ... $800.00
1 uA-1 A, 0-50 V compliance
KEITHLEY 261 Picoampere Source $375.00
KEITHLEY 614 Electrometer $800.00
KEITHLEY 642 Electrometer $2,900.00
TEK AM503/A6302/TM501 ..... $1,000.00
AC/DC Current Probe System
TEK CT-5 -opt.05 High Current $500.00
Transformer for P6021/A6302, to 1000A

IMPEDANCE & COMPONENT TEST

L.C.R.

BOONTON 62AD 1 MHz $550.00
Inductance Meter, 2-2000 uH
BOONTON 72BD 1 MHz $650.00
Capacitance Meter, 3-1/2 digit display
ESI 2160 LCR Bridge, 20 Hz-150 kHz, GPIB $2,000.00
HP 4262A-101 3-1/2 digit LCR Meter, ... $2,250.00
120 Hz/ 1 kHz/ 10 kHz test, HPIB
HP 4275A-001 5-1/2 digit LCR Meter, ... $6,000.00
10 kHz-10 MHz, 0-35 V int. bias

STANDARDS

E.S.I. DB62-11K 6-Decade Resistor, ... $300.00
0-11,111.10 Ohms, 0.01 Ohm res.
E.S.I. SR1010 Resistance Transfer $550.00
Standards, 1 Ohm-100 K/step
E.S.I. SR1050-1M Resistance $2,000.00
Transfer Standard, 1 Megohm/step
E.S.I. SR1-set Set of eight Standard $900.00
Resistors, 1 Ohm - 10 Megohms
GR 1404-A 1000 pF Reference Standard Capacitor $700.00
GR 1406 Standard Air Capacitors, ... $375.00
GR900 connector, 0.1% acc.
GR 1412-BC Decade Capacitor, 50 pF - 1.11115 uF $350.00
GR 1432-U 4-Decade Resistor, ... $125.00
0-111.10 Ohms, 0.01 Ohm resolution
GR 1433-J 4-Decade Resistor, ... $250.00
0-11,110 Ohms, 1 Ohm resolution
GR 1433-K 4-Decade Resistor, ... $250.00
0-1,110 Ohms, 0.1 Ohm resolution
GR 1433-L 4-Decade Resistor, ... $250.00
0-111,100 Ohms, 10 Ohms resolution
GR 1433-N 5-Decade Resistor, ... $300.00
0-11,111 Ohms, 0.1 Ohm resolution
GR 1433-U 4-Decade Resistor, ... $250.00
0-111.0 Ohms, 0.01 Ohm resolution
GR 1433-X 6-Decade Resistor, ... $350.00
to 111,111.0 Ohms, 0.1 Ohm res.
GR 1482-series Standard Inductors $275.00
VALHALLA 2724A Programmable $1,675.00
Resistance Standard, 0-11 Gigaohms, GPIB

HI & LO RESISTANCE

GR 1666 DC Resistance Bridge, ... $600.00
1 Micro-Ohm - 100 Kilohms
HP 4328A Milliohmeter $1,300.00
HP 4329A High Resistance Meter $1,200.00

CURVE TRACERS

TEK 577D1/177 Storage Curve Tracer, ... $2,250.00
with standard test fixture
TEK 577D2/177 Curve Tracer, with standard test fixture $1,850.00

T.D.R.

TEK 1502-opt.04 Time Domain Reflectometer, ... $1,400.00
0-2,000 feet, chart recorder
TEK 1503-opt.04 Time Domain $1,400.00
Reflectometer, 0-50,000 feet,chart recorder

POWER SUPPLIES

SINGLE OUTPUT

HP 6002A-001 0-60 V/ 0-10 A/ 200 Watts $750.00
max. Autoranging Power Supply
HP 6200B Dual Range Supply, ... $200.00
0-20 V 0-1.5 A/ 0-40 V 0-750 mA CVCC
HP 6201B 0-20 V 0-1.5 A CV/CC Power Supply $175.00
HP 6207B 0-160 V 0-200 mA CV/CC Power Supply $300.00
HP 6256B 0-10 V 0-20 A CV/CC Power Supply $300.00
HP 6260B-027 0-10 V 0-100 A CV/CC $675.00
Power Supply; 208 VAC line
HP 6261B-027 0-20 V 0-50 A CV/CC $675.00
Power Supply; 208 VAC line
HP 6263B 0-20 V 0-10 A CV/CC Power Supply $400.00
HP 6266B 0-40 V 0-5 A CV/CC Power Supply $400.00
HP 6267B 0-40 V 0-10 A CV/CC Power Supply $550.00
HP 6269B-028 0-40 V 0-50 A CV/CC $950.00
Power Supply; 230 VAC line
HP 6271B 0-60 V 0-3 A CV/CC Power Supply $400.00
HP 6274B 0-60 V 0-15 A CV/CC Power Supply $900.00
HP 6281A 0-7.5 V 0-5 A CV/CC Power Supply $175.00
HP 6284A 0-20 V 0-3 A CV/CC Power Supply $225.00
HP 6299A 0-100 V 0-750 mA CV/CC Power Supply $225.00
HP 6384A 4.0-5.5 V at 8 A CV/CL Power Supply $125.00
KEPCO ATE 36-30M 0-36 V 0-30 A CV/CC Power Supply $900.00
KEPCO ATE 36-8M 0-36 V 0-8 ..... $375.00
A CV/CC Power Supply
SORENSEN DCR 20-25B 0-20 V $550.00
0-25 A CV/CC Power Supply
SORENSON DCR 300-1.5B 0-300 V $600.00
0-1.5 A CV/CC Power Supply
SORENSON DCR 600-0.75B $600.00
0-600 V 0-750 mA CV/CC Power Supply
SORENSON SRL 20-12 y $400.00
0-20 V 0-12 A CV/CC Power Suppl
SORENSON SRL 60-8 ..... $600.00
0-60 V 0-8 A CV/CC Power Supply
TEK PS501-1 Power Supply, ... $175.00
0-20 V, 2 mV res., 400 mA, TM500 series

MULTIPLE OUTPUT

HP 6227B Dual 0-25 V 0-2 A CV/CC Power Supply $600.00
HP 6228B Dual 0-50 V 0-1 A CV/CC Power Supply $600.00
HP 6253A Dual 0-20 V 0-3 A CV/CC Power Supply $500.00
HP 6255A Dual 0-40 V 0-1.5 A CV/CC Power Supply $500.00
TEK PS5010 Programmable $750.00
Triple Power Supply, TM5000 series
TEK PS503A Dual Power Supply, TM500 series $200.00

MISCELLANEOUS

ACME PS2L-500 Programmable $400.00
Load, 0-75 V / 0-75 A / 500 Watts max.
HP 59501B HPIB Isolated DAC/ $175.00
Power Supply Programmer
HP 6825A Bipolar Power $800.00
Supply/ Amplifier, +/- 20 V 2 A
KEPCO BOP 50-2M Bipolar $400.00
Op Amp/Power Supply, to 50 V 2 A
TRANSISTOR DEVICES DAL-50-15-100 ..... $200.00
Programmable Load, 0-50 V, 0-15 A, 100 Watts max.

TIME & FREQUENCY

UNIVERSAL COUNTERS

FLUKE 1910A-02,03 125 MHz/ 500 nS $175.00
Universal Counter, TCXO reference
HP 5315A 100 MHz/100 nS Universal Counter $450.00
HP 5315A-002,003 100 MHz/100 nS $650.00
Univ. Counter, battery power, 1 GHz C-ch
HP 5315B 100 MHz/ 100 nS Universal Counter $500.00
HP 5316A 100 MHz/100 nS Universal Counter, HPIB $600.00
HP 5316A-001,003 100 MHz/ $750.00
100 nS Univ. Counter, HPIB, TCXO, 1 GHz C-ch.
HP 5316B 100 MHz/ 100 nS Universal Counter, HPIB $1,000.00
HP 5334A 100 MHz Universal Counter, HPIB $850.00
HP 5334A-010,030,050 100 MHz Univ. $1,000.00
Counter; OCXO, DVM, 1.3 GHz C-ch., rear in
HP 5334B-010,060 100 MHz $1,000.00
Universal Counter, HPIB, OCXO
HP 5335A 200 MHz Universal / Statistical Counter $1,200.00
TEK DC5004 Programmable 100 MHz/ $250.00
100nS Counter/Timer, TM5000 series
TEK DC5009 Programmable 135 MHz $400.00
Univ. Counter/Timer, TM5000 series
TEK DC5010 350 MHz / 3.125 nS $1,200.00
Universal Counter, TM5000 series

FREQUENCY COUNTERS

EIP 575 18 GHz Source Locking Counter, GPIB $2,500.00
EIP 578-opt.02,05 26.5 GHz Source $5,000.00
Locking Counter; power meas., OCXO
HP 5340A 18 GHz Frequency Counter $1,200.00
HP 5342A 18 GHz Frequency Counter $2,000.00
HP 5342A-001 18 GHz Frequency $2,200.00
HP 5342A-001,011 18 GHz Frequency $2,400.00
Counter, OCXO reference & HPIB
HP 5342A-003 18 GHz Freq.Counter, ... $2,000.00
+22 dBm,-20 dBm dynamic range
HP 5342A-01,04,05 24 GHz $3,250.00
Frequency Counter, OCXO, DAC
HP 5343A-001 26.5 GHz Frequency $4,500.00
Counter, OCXO reference
HP 5345A/5355A/5356B 26.5 GHz $4,000.00
CW/Pulse Frequency Counter
TEK DP501 1.3 GHz Prescaler, ... $225.00
divide by 16, TM500 series

STANDARDS

HP 105A Quartz Oscillator, 0.1/ 1.0/ 5.0 MHz $750.00
HP 105B Quartz Oscillator, ... $1,500.00
0.1/ 1.0/ 5.0 MHz, battery power
HP 5087A-opt.033 Distribution $1,750.00
Amplifier; 12 outputs at 10 MHz

AUDIO & BASEBAND

SPECTRUM ANALYSIS

HP 3586C Selective Level Meter, ... $1,500.00
50 Hz-32.5 MHz, 50 & 75 ohms
TEK 7L5/L3/R7603 Spectrum Analyzer, ... $1,500.00
20 Hz-5 MHz, 10 Hz min. res.,w/frame

DISTORTION ANALYZERS

HP 339A Distortion Analyzer, ... $1,500.00
built-in low distortion osc.

Write in 207 on Reader Service Card.

VISA

90 DAY WARRANTY PARTS AND LABOR • 10 DAY INSPECTION
TEST EQUIPMENT WANTED CALL OR FAX LIST • OPEN ACCOUNTS

MasterCard

HP 8903A-001 Audio Analyzer, 20 Hz-100 kHz; rear panel input $2,600.00
HP 8903B-001,013,051 Audio Analyzer, 20 Hz-100 kHz; C-message, CCITT $3,750.00
TEK DA4084 Programmable Distortion Analyzer $1,000.00

RMS VOLTMETERS

FLUKE 8920A True RMS Voltmeter, 180 uV-700 V, 10 Hz-20 MHz $500.00
FLUKE 8922A True RMS Voltmeter, 180 uV-700 V, 2 Hz-11 MHz $500.00

OSCILLATORS

HP 204C Oscillator, 5 Hz-1.2 MHz, 5 VRMS $150.00
HP 209A Sine/Square Wave Generator, 4 Hz-2 MHz, 5 VRMS max. $225.00
TEK SG5010 Programmable Oscillator, 10 Hz-163.8 kHz $2,750.00
TEK SG502 Sine/Square Osc., 5 Hz-500 kHz, 70 dB step atten.,TM500 ..... $200.00

MISCELLANEOUS

HP 3575A-001 Phase-Gain Meter, 1 Hz-13 MHz, dual display option $850.00
HP 4437A Step Attenuator, 0-119.9 dB, DC-1 MHz, 600 ohms unbal. $175.00
HP 461A Amplifier, 20/40 dB, 1 kHz-150 MHz, 0.5 V/50 Ohms $125.00
KROHN-HITE 3103 High/Low Pass Filter, 10 Hz-3 MHz, 24 dB/octave $400.00
KROHN-HITE 3202 Dual HP/LP/BP/BR Filter, 20 Hz-2 MHz, 24 dB/octave $500.00
KROHN-HITE 3342R Dual HP/LP Filter, 0.001 Hz-99.9 kHz, 48 dB/octave $1,100.00
KROHN-HITE 3750 LP/HP/BP/BR Filter, 0.02 Hz-20 kHz, 6/12/18/24 dB/oct. $700.00
ROCKLAND 852 Dual Highpass/Lowpass Filter, 0.1 Hz-111 kHz $1,000.00
TEK AF501 Tunable Bandpass Filter / Amplifier, 3 Hz-35 kHz $300.00
TEK AM502 Differential Amplifier, 0.1 Hz-1 MHz, TM500 series $475.00

RF & MICROWAVE

SPECTRUM ANALYZERS

HP 11517A/19A/20A Mixer Set, 18.0-40.0 GHz, for HP 8555A/8569A $600.00
HP 11970A WR28 Harmonic Mixer, 26.5-40 GHz $1,100.00
HP 11970K WR42 Harmonic Mixer, 18.0-26.5 GHz $1,100.00
HP 11970Q WR22 Harmonic Mixer, 33-50 GHz $1,400.00
HP 11970U WR19 Harmonic Mixer, 40-60 GHz $1,400.00
HP 8444A-059 Tracking Generator, 0.5-1500 MHz, for 8554,8568,etc. $1,250.00
HP 8445B Preselector, 1.8-18.0 GHz, for HP 8555A $650.00
HP 8565A-100 Spectrum Analyzer, 10 MHz-22 GHz, 100 Hz min. res. $4,500.00
HP 8566B Spectrum An., 100 Hz-22 GHz, HP calibration certificate $37,500.00
HP 8569B Spectrum Analyzer, 10 MHz-22 GHz, 100 Hz min.res.bw. $7,500.00
TEK TR503 Tracking Generator, 0.1-1800 MHz, for 492/4/5/6 ..... $1,375.00
TEK WM782V WR15 Harmonic Mixer, 50-75 GHz $2,000.00

NETWORK ANALYZERS

HP 3577A/35677A/35678A Network Analyzer, 5 Hz-200 MHz, w/S-Parameter & Cal.Kit $12,500.00
HP 85021C Directional Bridge, 0.01-18 GHz, 33 dB dir,for 8755/6/7 ..... $1,000.00

SIGNAL GENERATORS

FLUKE 6060A Synthesized Signal Gen., 0.1-1050 MHz, 10 Hz res., GPIB $2,750.00
FLUKE 6060A/AN Synthesized Signal Gen., 10 kHz-520 MHz, 10 Hz res.,GPIB $1,750.00
GIGATRONICS 600/10-18 Synthesized Source, 10-18 GHz, 1 kHz res., GPIB $3,000.00
GIGATRONICS 875/50 Levelled Multiplier, x4, 50.0-75.0 GHz output, -3 dBm $3,500.00
GIGATRONICS 875/86 Levelled Multiplier, 26.5-40.0 & 50.0-75.0 GHz outputs $5,000.00
HP 11720A Pulse Modulator, 2-18 GHz, 80 dB on/off ratio $750.00
HP 85100V Frequency Mult., 10-15 GHz in / 50-75 GHz out >0 dBm $4,250.00
HP 8640B-001,002 Signal Gen., 0.5-1024 MHz, AM, FM, var. audio osc. $1,750.00
HP 8660C/86602B-002 Synth. Sig. Gen., 1-1300 MHz, FM / Phase mod. w/86635A $3,250.00
HP 8660C/86603A/86633B Synthesizer, 1-2600 MHz, AM, FM $3,750.00

SWEEP GENERATORS

HP 8350B/83592B-002 Sweep Generator, 10 MHz-20 GHz, 70 dB step attenuator $18,500.00
HP 8601A Generator/Sweeper, 0.1-110 MHz, +20 dBm levelled $400.00
HP 8620C Sweep Oscillator Frame $550.00
HP 8620C-011 Sweep Oscillator Frame, HPIB programmable $675.00
HP 86222B-002 RF Plug-in, 10-2400 MHz, +13 dBm levelled, 70 dB atten. $1,750.00
HP 86230B RF Plug-in, 1.8-4.2 GHz, +10 dBm unlevelled $675.00
HP 86235A-001,002 RF Plug-in, 1.7-4.3 GHz, +14 dBm levelled, 70 dB atten. $700.00
HP 86240C RF Plug-in, 3.6-8.6 GHz, +16 dBm levelled $750.00
HP 86241A-001 RF Plug-in, 3.2-6.5 GHz, +8 dBm levelled $400.00
HP 86242D-004,008 RF Plug-In, 5.9-9.0 GHz, +10 dBm levelled $400.00
HP 86250D RF Plug-in, 8.0-12.4 GHz, +10 dBm levelled $600.00
HP 86260A RF Plug-in, 12.0-18.0 GHz, +10 dBm unlevelled $700.00
HP 86260A-H04 RF Plug-in, 10.0-15.0 GHz, +10 dBm unlevelled $700.00
HP 86290A RF Plug-in, 2.0-18.0 GHz, +7 dBm levelled $1,750.00
HP 86290B RF Plug-in, 2.0-18.6 GHz, +10 dBm levelled $2,000.00
WAVETEK 962 Sweep Generator, 1.0-4.0 GHz, markers, +12 dBm unlvld. $1,500.00
WILTRON 6619A Sweep Generator, 2-8 GHz, +10 dBm levelled $1,500.00

POWER METERS

ANRITSU MA72B Power Sensor, -20 to +20 dBm, 0.01-18 GHz $300.00
ANRITSU MP-81B/ML-83A Power Meter, 75-110 GHz (WR10), -20 to +20 dBm $2,500.00
BOONTON 4200-01A,03/&-4A x2 Dual Channel Microwattmeter, w/(2) 1 MHz-7 GHz sensors $1,500.00
BOONTON 42B/41-4B Analog Power Meter, with 1 MHz-12 GHz sensor $375.00
BOONTON 42B/41-4E Analog Power Meter, with 1 MHz-18 GHz sensor $500.00
GENERAL MICROWAVE 476/4240A Power Meter & Sensor, 0.01-18 GHz, -35 to +10 dBm $300.00
HP 435A/8481A Power Meter, 10 MHz-18 GHz, -30 to +20 dBm $900.00
HP 435A/8482H Power Meter, 0.1-4200 MHz, -10 to +34 dBm $950.00
HP 435B-001/8482H Power Meter, 0.1-4200 MHz, AC or battery power $1,200.00
HP 8477A Power Meter Calibrator, for HP 432 series $500.00
HP Q8486A Power Sensor, 33.0-50.0 GHz, WR22, for 435/6/7/8 ..... $1,500.00
HP R486A WR28 Thermistor Mount, 26.5-40 GHz, for 432 series $350.00
HP R8486A WR28 Power Sensor, -30 to +20 dBm, 26.5-40 GHz $1,500.00

RF MILLIVOLTMETERS

BOONTON 92BD 3-1/2 digit RF Millivoltmeter, 10 kHz-1.2 GHz $600.00
RACAL 9303 TRMS Level Meter, 10 kHz-2 GHz, -77 to +23 dBm, GPIB $875.00

AMPLIFIERS, MISCELLANEOUS

BOONTON 82AD-opt.01A Modulation Meter, AM, FM, 10-1200 MHz, GPIB $900.00
HP 11715A AM/FM Test Source $1,600.00
HP 415E SWR Meter $300.00
HP 465A Amplifier, 20/40 dB, 5 Hz-1 MHz, 1/2 Watt/50 Ohms $125.00
HP 8447A-001 Dual Amplifier, 0.1-400 MHz $450.00
HP 8447E Amplifier, 22 dB, 0.1-1300 MHz, +13 dBm output $750.00
HP 8447F Preamplifier / Power Amplifier, 0.1-1300 MHz $1,200.00
HP 8901A Modulation Analyzer, 150 kHz-1300 MHz $3,000.00
HP 8901B-1,2,3 Modulation An., 0.15-1300 MHz, rear input, OCXO, ext.LO $4,500.00
HP 8970A Noise Figure Meter $5,000.00
HUGHES 1177H01F000 TWT Amplifier, 2.0-4.0 GHz, 10 Watts output $1,500.00
HUGHES 1177H02F000 TWT Amplifier, 4.0-8.0 GHz, 10 Watts output $1,500.00
HUGHES 1277H02F000 TWT Amplifier, 4.0-8.0 GHz, 20 Watts output $2,500.00
HUGHES 8020H02F000 TWT Amplifier, 4.0-8.0 GHz, 20 Watts output $2,750.00
MICROWAVE SEMI.CORP. MC5112 Noise Source, 25.5 dB ENR, 1.0-12.4 GHz, N(m), +28 VDC $275.00
ROHDE & SCHWARTZ ESH2 Test Receiver, 9 kHz-30 MHz $6,000.00

COAXIAL & WAVEGUIDE

AMERICAN NUCLEONICS AM-432 Cavity Backed Spiral Antenna,LHC, 2-18 GHz,TNC(f) *NEW* $95.00
BIRD 8329-310 30 dB Attenuator, 2000 Watts, DC-1 GHz, LC(f)/N(f) $650.00
FXR/MICROLAB S3-02N Triple Stub Tuner, 200-1000 MHz, 100 Watts max., N(m/f) $125.00
GR 874-LTL Constant Impedance Trombone Line, 0-44 cm, DC-2 GHz $400.00
GR 900-Q GR900 14mm Interseries Adapters $125.00
HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC7 ..... $450.00
HP 11612A Bias Network, 45 MHz-26.5 GHz, APC3.5 ..... $550.00
HP 11691D Directional Coupler, 22 dB, 2-18 GHz $450.00
HP 774D Dual Directional Coupler, 20 dB, 215-450 MHz $275.00
HP 777D Dual Directional Coupler, 20 dB, 1.9-4.1 GHz $275.00
HP 778D-011 Dual Dir. Coupler, 20 dB, 100-2000 MHz, APC7 test port $450.00
HP 8470B Crystal Detector, 10 MHz-18 GHz, neg. pol., APC7 ..... $250.00
HP 8472A Crystal Detector, 10 MHz-18 GHz, neg. pol., SMA $150.00
HP 8494G-002 Programmable Step Attenuator, 0-11 dB, DC-4 GHz, SMA $350.00
HP 8495G-002 Programmable Step Attenuator, 0-70 dB, DC-4 GHz, SMA $300.00
HP 8495H-002 Programmable Step Attenuator, 0-70 dB, DC-18 GHz, SMA $400.00
HP 8497K-004 Programmable Step Attenuator, 0-90 dB, DC-26.5 GHz $750.00
HP K422A WR42 Flat Broadband Detector, 18.0-26.5 GHz $350.00
HP K532A WR42 Frequency Meter, 18.0-26.5 GHz $450.00
HP K870A WR42 Slide Screw Tuner, 18.0-26.5 GHz $275.00
HP K914B WR42 Moving Load, 18.0-26.5 GHz $350.00
HP Q752D WR22 Directional Coupler, 20 dB, 33-50 GHz $650.00
HP R375A WR28 Variable Attenuator, 0-20 dB, 26.5-40 GHz $375.00
HP R532A WR28 Frequency Meter, 26.5-40 GHz $500.00
HP R752A WR28 Directional Coupler, 3 dB, 26.5-40 GHz $450.00
HP R914B WR28 Moving Load, 26.5-40 GHz $300.00
HP V365A WR15 Isolator, 25 dB, 50-75 GHz $900.00
HP V752D WR15 Directional Coupler, 20 dB, 50-75 GHz $650.00
HP X870A WR90 Slide Screw Tuner $150.00
HUGHES 45111H-2000 WR28 Isolator, 25 dB, 26.5-40 GHz $450.00
HUGHES 45712H-1000 WR22 Frequency Meter, 33-50 GHz $900.00
HUGHES 45721H-2000 WR28 Precision Rotary Vane Atten., ... $1,200.00
HUGHES 45732H-1200 WR22 Level Set 0-50 dB, 26.5-40 GHz $250.00
HUGHES 47316H-1111 WR10 Tuneable Attenuator, 0-25 dB, 33-50 GHz $600.00
HUGHES 47323H-1211 WR19 Flat Broadband Detector, positive polarity $650.00
HUGHES 47974H-1000 WR15 SPST Detector, negative, 40-60 GHz $375.00
KAY 442D Step Attenuator, 0-101 dB, 75 ohms, BNC PIN Switch, 250 MHz speed, 60-62 GHz response $100.00
KRYTAR 1818 Directional Coupler, 0-101 dB, 75 ohms, BNC $200.00
M/A-COM 3-19-300/10 WR19 Directional Coupler, 16 dB, 2-18 GHz, SMA(f) $450.00
MIDWEST MICROWAVE 3537 DC Block, Coupler, 10 dB, 40-60 GHz $40.00
MINI-CIRCUITS ZFDC-20-4 Directional Coupler, 19.5 dB, 1-1000 MHz, SMA(f) $25.00
NARDA 25171 Level Set Attenuator, 0-17 dB, 2-8 GHz, SMA(f) $100.00
NARDA 26298 20 dB Attenuator, 150 Watts, DC-1 GHz, N(f/f) $200.00
NARDA 3000-SERIES Directional Couplers $150.00
NARDA 3024 Bi-Directional Coupler, 20 dB, 4-8 GHz $300.00
NARDA 3090-SERIES Precision High Directivity Couplers $225.00
NARDA 368NM Coaxial High Power Load, 500 Watts, 2.0-12.4 GHz, N(m) $400.00
NARDA 369BNF High Power Termination, 175 Watts, 0.7-18 GHz, N(f) $325.00
NARDA 3753B Coaxial Phase Shifter, 0-55 deg./GHz, 3.5-12.4 GHz $1,250.00
NARDA 4000-SERIES SMA Miniature Directional Couplers $75.00
NARDA 4245-10 Directional Coupler, 10 dB, 4-12 GHz, SMA(f) $100.00
NARDA 4799 Level Set Attenuator, 0-15 dB, 4-18 GHz, SMA(f) $135.00
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DIVIDE by aN

by E. Z. Camp

The front office had the usual computer intercom grid and recited its standard message in a rather sexy voice, "Enter your Social Security number, puh-lease!" I keyed in the numbers ingrained in my soul and sat down to wait. Shortly, the door to the 'dressing' room glided open, revealing an immaculate expanse of production computers lining the walls of the factory. The glass double-airlock doors cycled and a young man dressed in a 'bunny' suit exited the clean room.

"You must be Skip," he said, as he removed a glove and shook my hand with enthusiasm. "I'm Joe, the line manager. Glad you could make it today! Come right in."

"Thanks, Joe. I almost missed the shuttle — for once, it was on time!" My shoes were sticking to the 'tacky' mat.

"I know the feeling. It gets tough to find a comfortable Gee seat on that old shuttle, too."

"Tell me about it! I had to scrape my kidneys off the floor after the high-gee run over here," I said, while massaging my aching back. Damn, I felt like I would be peeing blood for a week!

"Well, let's get you suited up and we'll go in and meet the rest of the staff." With that, Joe helped me into the white plastic coverall which covered everything, including my beard.

Let me state here and now: I HATE BUNNY SUITS! They bind and they don't breathe and, being of Italian heritage, I tend to sweat at anything over 60 degrees. And God forbid you should 'pass wind' while in one. You just might suffocate!

Properly attired, we entered the Sanctum Sanctorum. A stiff breeze came up through the floor grids, recycling the entire room's air volume about once per minute. The ceiling installed filter units were quite impressive and surprisingly quiet, considering their enormous proportions.

"Betty, this is the journalist I told you about. Skip, meet Betty, our programmer-deluxe!"

Betty was a cute little job that didn't quite top five feet, but she had that 'look' of authority and intelligence that couldn't be ignored. She was the BOSS! A great head of hair and terrific legs were probably hidden under that suit!

"Hello, Skip. I'll be giving you the grand tour today, and then we'll talk to the tech who dreamed up the new operation." She shook my hand — it tingled.

I had a hard time keeping up with her — she could really travel, even in that bunny suit of hers! But she was terrific at explaining how the computers ran the electronic component production line. Fascinating stuff, to say the least.

"I understand that these processes were carefully guarded trade secrets until now, Betty. Why are you going public?"

"To be quite frank, Skip, all of this you see in here now will be mostly obsolete in six months or a year. Our new operation will probably change the entire concept of electronics, as we now know it."

I was stunned. It began to look like I was in on the ground floor of something big. I might actually make some money on this next article!

"Until now, nobody actually knew or really cared what the components exactly DO that end up in our final products," Betty said. "The computers do such a terrific design job that we never have to worry about anything except the end result."

I asked, "Well, who designs the components themselves?"

"The computers handle that aspect, also," answered Joe.

"Their programs include design procedures from the final products down to the component level — we just tell them what we want as a final product. They do all of the design and material handling to achieve the correct results."

I had already surmised much of this through Betty's excellent tour of the facility, but didn't appreciate just HOW automated this operation really was!

Betty headed for a cordoned-off area in the rear of the plant. "This is our engineering section, run by our 'idea man' Bill, the best tech in the business."

"Hi Bill, I'm Skip." Bill was a massive man, who looked capable of anything BUT providing ideas, however, his handshake didn't cripple me as expected. "So, what's the skinny, Bill?"

Bill gave Betty a glance and she said, "It's okay, Bill, give him the works. He understands that this won't be published until we're in full pro-

duction, right Skip?"

"You better believe it, folks! I'm quite honored to be the one reporting this for your company, and I would never betray your trust." Oh Brother! From a journalist, no less!

Bill began, "Okay Skip, it all started when I began wondering what the exact functions are of all these parts we make here. I mean, what exactly is a resistor or a capacitor, and what does it do? The computers 'know' because they do all of the design work, and up till now were thought to have invented all of these components, including the logic chips."

My mouth dropped open, "Are you telling me that they didn't?"

Bill smiled, "Far from it! Let me explain. I had to really dig for information and it wasn't easy, but it's all there if you know where to look. That's why we're trying to keep this under wraps until we're in full production."

"That's Bill's real talent, actually finding this stuff," said Betty, "not to mention knowing what to do with it."

"I didn't go it alone," Bill added, "We had a good team running search routines through the computer archives for months before stumbling on the right files."

"Bill designed those search routines himself," offered Joe, obviously proud of Bill's results.

Bill sighed, "The routines were not too difficult, but breaking the machine codes was a real stinker! That's where Betty's programming skills really helped. Once we did that, though, we were on our way."

"Okay, so what exactly did you find?" I was trying not to sound TOO impatient.

"Well, the evidence was sketchy. The files don't contain much more than formulas, materials, manufacturing processes, and the like. However, we were able to piece all of this information together and actually put it into practice. As it turns out, it appears that a woman back in the 20th Century actually did the majority of the original design work."

Betty was grinning, "She must of been one hell of an inventor!"

Bill agreed, "We tried duplicating her work and managed to fabricate what she called 'discrete' devices. Using some of our components with leads soldered onto them, we were able to design and build her LINEAR AMPLIFIER. Let me tell you, Skip, these types of designs separate the men from the boys, or should I say, the ladies from the girls?"

Laughing, Betty said, "We found out that the 'discrete' device is called a transistor, and is essentially the same device used as switches in all of our modern logic chips, which use many thousands of them. The switching action of all these transistors provides the machine language in the binary number system for processing."

"Here's the best part, Skip," said Bill, "Logic chips only use the transistors for their on/off ability, but it turns out that they can be biased with the proper current level into their linear regions."

I didn't follow him, "What does that mean?"

"That means that they can AMPLIFY an input signal. Put in a small signal, get out a larger signal, and do it linearly. And, if you combine a few of these transistors in one circuit, you can do math operations with unlimited resolution. Plus, the answer arrives in 'real time.' You don't have to wait for the computed results!"

All I could say was, "WOW!"

Betty was having a hard time containing herself as she said, "What you are seeing in this cabinet here, Skip, is the first real-time computing system. It will still use our standard memory banks for data, but that will change shortly. We are in the final design stages of a real-time memory system. Very soon now, you can forget all about access times! And the possibilities seem to be endless for linear technology."

Joe was choking down his pride as he added, "We are now in the process of designing a new communications system using linear components. And we have a few more research teams working on test equipment, audio and video equipment, and a lot of standard consumer goods. The market is wide open, I tell you!"

"We are also developing some other discrete devices mentioned in the files," added Betty. "There appears to be many types of diodes and transistors with varying electrical characteristics. We will then attempt to 'integrate' these onto one chip. We are still learning all we can about passive components, and the laws for their use in a circuit. It's a big new field, but we're almost there."

"Well it looks like you folks have the world-by-the-tail," I said, "but I need to know one more thing for my article: Who was this great lady that invented all of this?"

Bill replied, "That was the most difficult piece of data to translate. The memory disk was damaged and the data was 'smeared' into one word, but we're 99% sure her name was Anna."

"Yes," said Betty, "Ms. Anna Log." **NV**

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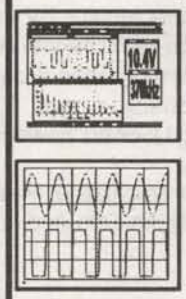

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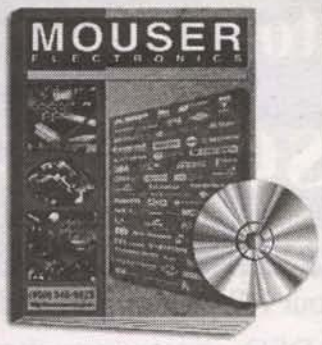

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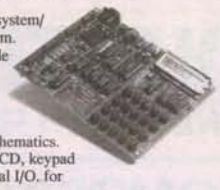

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TECH FORUM

Continued from page 26

voltages required (5V, 12V, and -5V).

The rest of the game logic works just fine with only 5V.

While you have the game open, remember to change the memory backup batteries so they don't leak and destroy your CPU board. Hundreds of games have been lost to leaking batteries.

Once you resolder the molex pins, the game will probably work. If it doesn't, the 4116 RAM chips are available at BG Micro (Phone 214-271-5546. www.bgmicro.com).

Personally, I prefer to replace the 4116 RAM chips with modified 4164 RAMs pulled from IBM XT motherboards since 4164s only require 5V and are much more reliable. I can supply you with the info regarding this mod.

For more info regarding video arcade game collecting and repairing, check out the rec.games .video.arcade.collecting USENET newsgroup. Most of what I know, I learned there.

I have manuals for this game. Please contact me via E-Mail: gonzothegreat@juno.com and I can get you a copy.

Alan McCormick
Madison, WI

ANSWER TO #8984 - AUG. 1998

I assume you are interested in weather satellite reception, since 138.85 MHz is the frequency for the Russian meteor satellites.

A kit is available from Hamtronics, 65 Moul Road, Hilton, NY 14468-9535, so you might want to contact them and request their catalog. Their R-139 receiver kit is available, specifically for this purpose, and the cost is $159.00. Wired and tested, it goes for $239.00, complete with cabinet and AC adapter.

Hamtronics also offers a lot of other quality kits and factory assembled devices for radio amateurs and others interested in UHF-VHF radios, repeaters, data modems, autopatches, and the like.

They usually have ads in *QST*, *CQ*, and other magazines directed toward the radio amateur audience, but about 50% of their equipment is utilized by people in various other scientific, broadcast, governmental agencies, etc.

Since their equipment is designed in a modular fashion, it is relatively easy to adapt to a variety of projects. I have found their products to be of high quality, and their engineering people have been most helpful in helping me to select and adapt their products to various engineering applications.

I doubt that you can design and build a 138 MHz receiver of this quality for anything less than their R-139 kit sells for, and it includes detailed instructions and drawings. Their phone number is 716-392-9430 (fax 716-392-9420).

Dwight A. Johnson
Booneville, MS

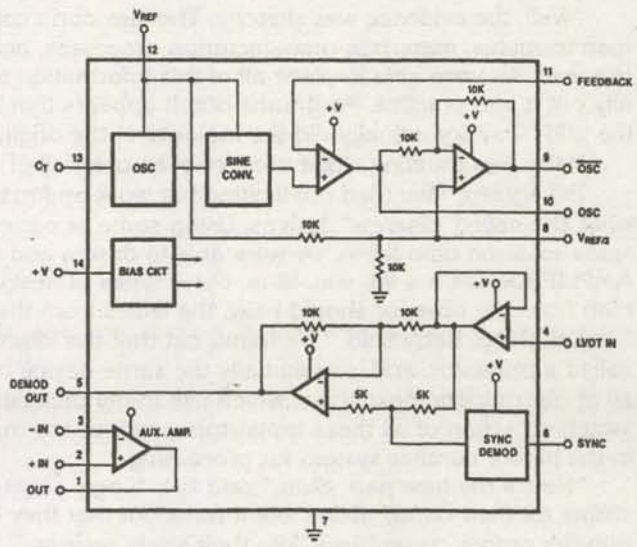
ANSWER TO #89811 - AUG. 1998

I don't know where you can get the NE5520 LVDT chip, but you can build an equivalent.

The chip has five important blocks, a sine generator, differential driver, secondary voltage follower, synchronous demodulator, and an auxilliary opamp for a low-pass filter.

These blocks are evident in the NE5520 block diagram given in the the Signetics datasheet.

You can make the sine generator with a function generator chip (e.g., XR2206 or XR8038/ ICL8038).



These chips produce a diode-shaped sinewave that has a stable output level. You can make the differential driver with two opamps: a voltage follower and a voltage inverter as in the block diagram, but you will probably have to AC couple the outputs to the LVDT primary unless the primary has a DC resistance of a few kilohms.

The OSC and OSC_BAR output drive the LVDT primary.

A voltage follower buffers LVDT_IN to minimize loading the LVDT secondary winding.

The clever part of the NE5520 is the synchronous demodulator. It consists of a comparator (to change the SYNC input to a logic level) that drives an analog switch (to connect the junction of the two 5K resistors to VREF/2).

The analog switch synchronously alternates the DEMOD OUT amplifier gain between ±1. An MC1496 could also serve as the demodulator. The auxilliary opamp is part of a low-pass filter that kills unwanted demodulation products.

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by Joseph J. Carr

Gates: The Basic Building Blocks of Digital Circuits

Several elementary forms of digital logic gates form the basic building blocks out of which even the most complex digital circuits are formed. Even the most complex microprocessor chip, with clock speeds that sound like radar frequencies, is little more than a specific large-scale configuration of the same basic gate elements. There are only a few basic types of logic gates, but they can be combined to form all manner of high-level integrated circuit digital devices. The basic forms of gates are:

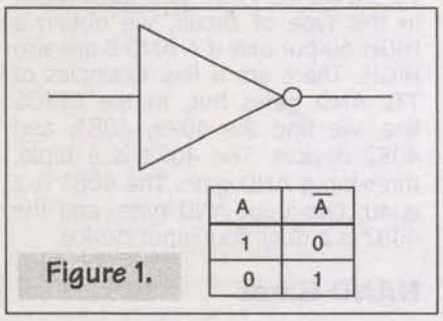
- NOT gate
- OR gate
- AND gate
- NOR gate
- NAND gate
- XOR gate

Examples of these gates can be found as stand-alone functions in all of the standard integrated circuit logic families and sub-families.

NOT Gates (Inverters)

Figure 1 shows the schematic circuit symbol and truth table for the most elementary type of gate. This gate is called by various names: NOT gate and inverter.

The action of the NOT gate is simple: the output is always the opposite state as the input. Thus, when the input is LOW, the output is HIGH. And when the input is HIGH, the output is LOW. In other words, the NOT gate inverts the input signal, hence its alternate name "inverter." An alternate name — complementer — comes from the fact that the NOT gate complements the input. In digital arithmetic, the complement of a digit is its opposite. Thus 1 is the complement of 0, and 0 is the complement of 1. Or, put another way, HIGH and LOW are complements of each other.



A	$\overline{A}$
1	0
0	1

Figure 1.

The term "NOT" comes from the fact that the states are binary in nature, so can only be either of two possible states: HIGH and LOW. If a signal is HIGH, then it cannot be LOW or, put another way, HIGH = NOT-LOW. Or alternatively, LOW = NOT-HIGH.

In some cases, a special notation is used to designate the complemented state. If "A" represents a signal, then an "A" with a bar over it ("bar-A") is the NOT-A. Because of the difficulty in typing such a character, I will retain the denotation "NOT-A" in text, but will occasionally use bar-A in illustrations.

Truth tables are used in discussing digital circuits. Such tables show all possible states and their relationship to one another. For the NOT gate, the truth table is simple:

A	NOT-A
0	1
1	0

This table tells us that whenever input "A" is at logical level 1 (i.e., HIGH), then the output "NOT-A" is at logical level 0 (LOW). In the dynamic situation, "A" drops from HIGH-to-LOW, then NOT-A snaps LOW-to-HIGH.

The schematic circuit symbol for the inverter is shown in Figure 1. It is a triangle with a circle on the output terminal (the input terminal is at the middle of the side opposite the output). Anytime you see a digital logic element symbol with a circle at the output, then it means that the output will have the opposite state of the input, or some other terminal. In the case of the inverter, the output is opposite the input so the circle is at the input. In certain other logical elements, an output designated Q will often have a complementary output NOT-Q.

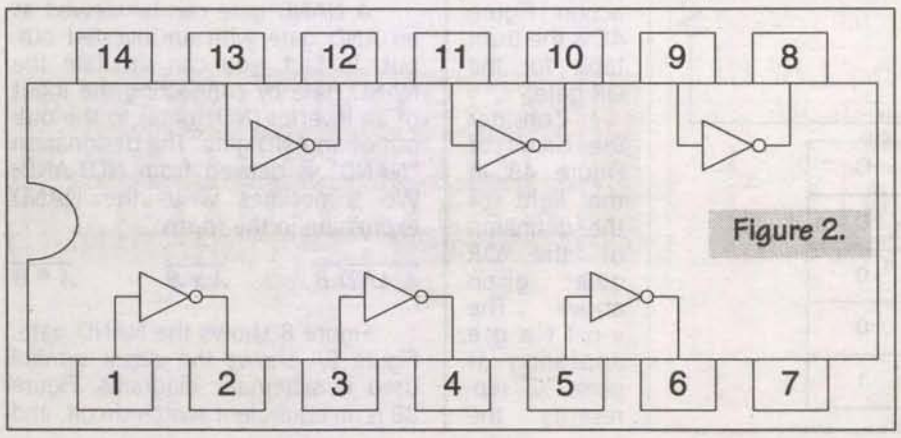


Figure 2.

Multi-input Symbols. Sometimes, you will see a multi-input circuit symbol in which the circle is on an input. That means that the inversion occurs only for that input, and not for others.

Buffers. There is another device used in digital circuits called a buffer. It looks like an inverter, but without the output circle that denotes inversion. These are sometimes also called non-inverting buffers. Such devices produce an output that is identical to the input (A = A). There are two reasons for using buffers. One is to provide isolation between the circuit from which the signal is received and its destination. The most important use, however, is to increase the drive level of the circuit. The drive capability of a digital circuit is described by its fan-out, i.e., the number of inputs of the same type of logic family that the output can drive. A fan-out of 10, for example, means that the output can drive 10 standard input terminals. Buffers typically have higher fan-outs than straight gates.

Another use for a buffer is to drive long transmission lines. The digital signals look like pulses to transmission lines, and will deteriorate by the time the signal traverses the line. Using a buffer with a sufficiently high capacity to drive the line will limit this effect.

The device shown in Figure 2 is called a hex inverter. It contains six inverters that are totally independent of each other except for sharing common DC power supply terminals (+5 VDC and ground). There is no interaction between the inverters unless external connections are made between the inputs and outputs. On the TTL version of this chip, the average current drain is 12 to 15 mA.

Figure 3 shows the pinouts for the 4049 and 4069 CMOS hex invert-

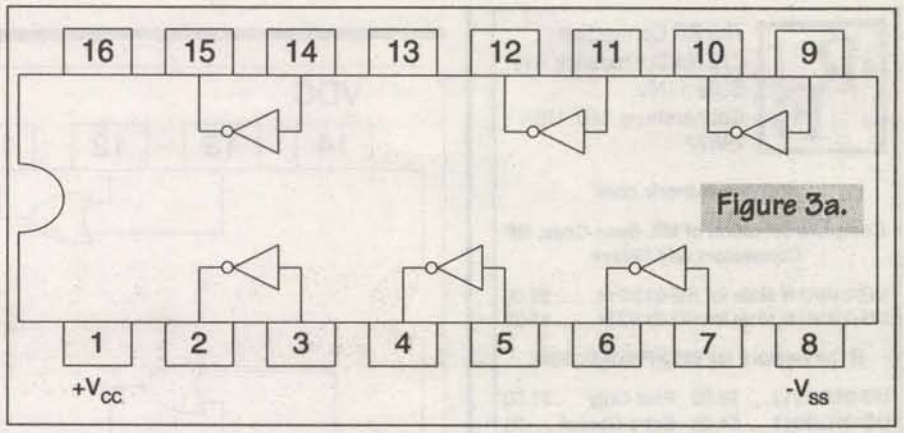


Figure 3a.

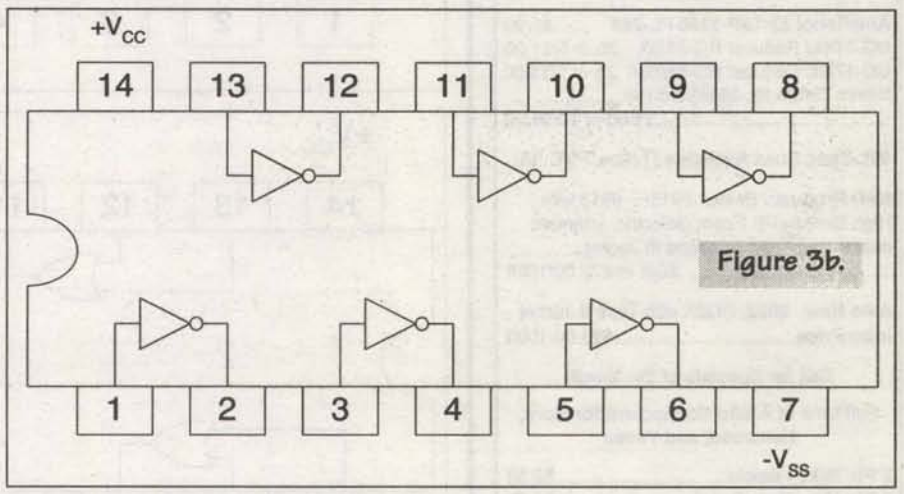
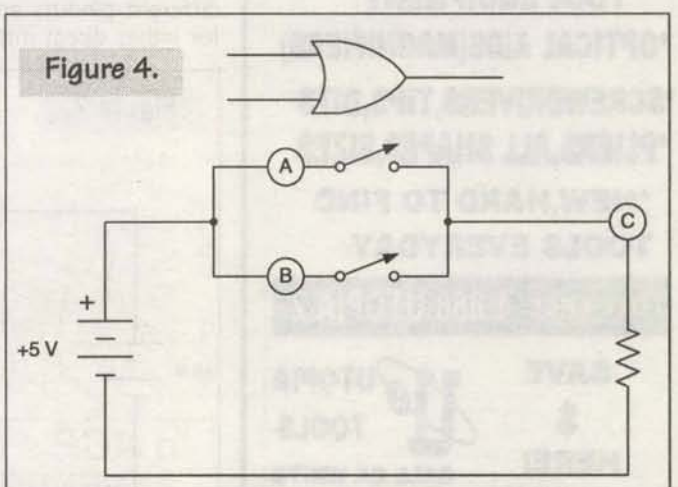


Figure 3b.

Figure 4.



A	B	C
0	0	0
0	1	1
1	0	1
1	1	1

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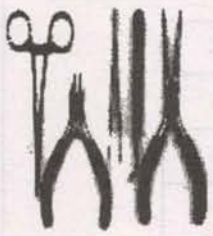

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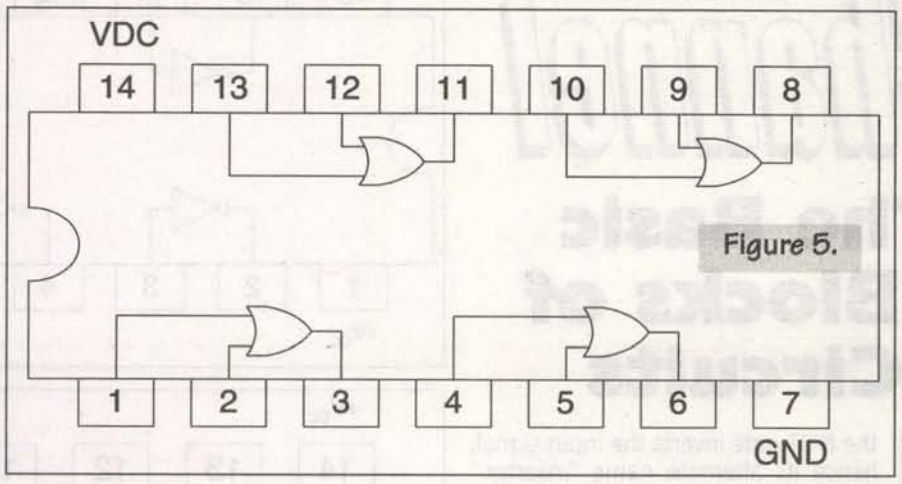


Figure 5.

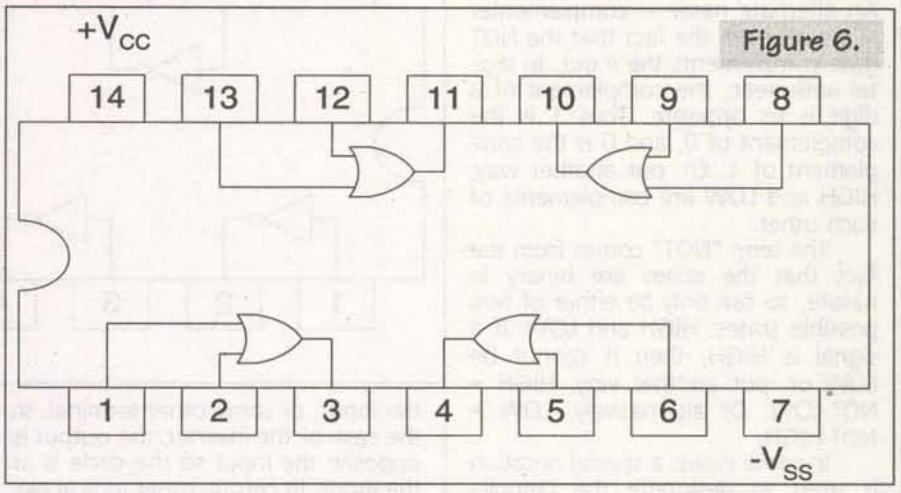


Figure 6.

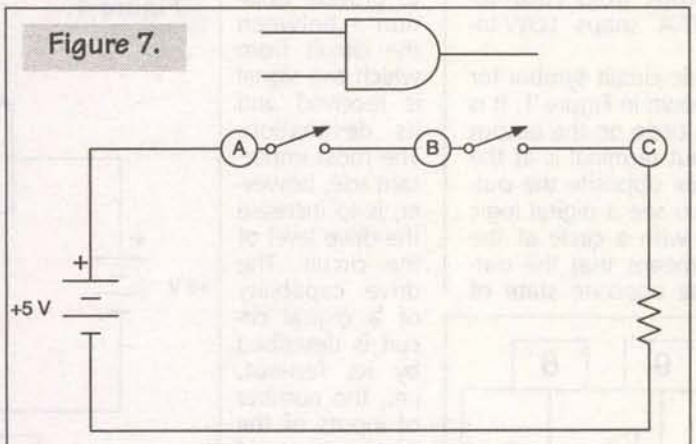
er devices. The 4049 device may be used as a level translator between +5 VDC TTL devices and those CMOS devices that are operated at potentials other than +5 VDC. The voltage applied to pin no. 1 defines the output voltage swing, so if +5 VDC is used, the device becomes TTL compatible, even though it is a CMOS device. The 4049 can handle up to 3.2 mA of current, so will drive two standard TTL inputs (i.e., fan-out of 2). The input voltages applied to the 4049 device can swing to +15 VDC, regardless of the voltage applied to pin no. 1.

Although some people call the 4069 device a "low-power" version of the 4049, it is not. The 4069 has different pinouts and is not suitable for either direct interfacing with TTL logic or level translation of any type. The 4069 will interface directly with other CMOS devices.

The difference between the current drains of TTL and CMOS devices can be seen by comparing the 7404 and 4069 devices. At +5 VDC — which is used by traditional TTL devices — the 4069 device requires only 0.5 mA, as opposed to 15 mA for the 7404. This is a difference of 3,000 percent! It is little wonder that designers have opted for the CMOS and related families wherever possible.

OR Gates

An OR gate produces a logical-1 (or "HIGH") output if any input is logical-1. Figure 4A shows the schematic circuit symbol for an OR gate, while Figure 4B shows an equivalent circuit made from ordinary switches. The model circuits produces the same sort of action. Figure 4C is the truth table for the OR gate.



A	B	C
0	0	0
0	1	0
1	0	0
1	1	1

Figure 7.

Consider the circuit of Figure 4B in the light of the definition of the OR gate given above. The voltage appearing at point "C" represents the output of the OR gate, while switches "A" and "B" represent the inputs. The switches' logical states are as follows:

Switch Condition	Input Logic Level	Output Condition
Open	0 (LOW)	LOW
Closed	1 (HIGH)	HIGH

By the definition of an OR gate, we would expect "C" to be HIGH when either input is HIGH. In other words, if either switch "A" OR Switch "B" (denoted A OR B) is closed, then the output at "C" is HIGH. This is exactly the action found in the circuit of Figure 4B. Voltage C goes to +5 VDC if either switch is closed and will be zero only if both switches are open. This condition is reflected in the truth table shown in Figure 4C: C is HIGH if A OR B is also HIGH.

Examples of TTL and CMOS OR gate ICs are shown in Figures 5 and 6, respectively. The type 7432 device is a quad, two-input OR gate. Note that the V+ and ground terminals are pins 14 and 7, respectively. Other than the power supply connections, all four gates are independent. This is the same DC power supply pinout found on the 7404 device discussed earlier. The 7432 requires approximately 20 mA of current, although newer devices require considerably less.

The CMOS example — a 4071 device — is shown in Figure 6. This IC is also a quad, two-input OR gate. The current requirement is only 0.5 mA, so you can see the advantage that CMOS has over TTL (where speed is not a factor). The propagation delay time is 12 nanoseconds (ns) for TTL and 80 ns for CMOS.

AND Gates

The AND gate produces a HIGH output if, and only if, both inputs are HIGH, and a LOW output if either input is LOW. Figure 7A shows the circuit symbol for an AND gate, while Figure 7B shows an equivalent switch circuit that does the same job. Figure 7C shows the AND gate truth table. In this type of circuit, we obtain a HIGH output only if A AND B are also HIGH. There are a few examples of TTL AND gates but, in the CMOS line, we find the 4073, 4081, and 4082 devices. The 4073 is a triple, three-input AND gate. The 4081 is a quad, two-input AND gate, and the 4082 is a dual, four-input device.

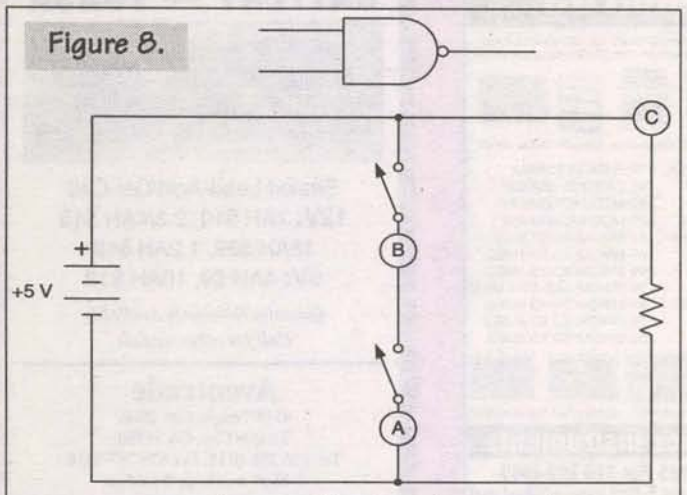
NAND Gates

A NAND gate can be viewed as an AND gate with an inverted output. In fact, you can simulate the NAND gate by connecting the input of an inverter (NOT gate) to the output of an AND gate. The designation "NAND" is derived from NOT-AND. We sometimes write the NAND expression in the forms:

$\overline{A \text{ AND } B}$ $\overline{A \times B}$ $\overline{A \bullet B}$

Figure 8 shows the NAND gate. Figure 8A shows the circuit symbol used in schematic diagrams. Figure 8B is an equivalent switch circuit, and

Figure 8.



A	B	C
0	0	1
0	1	1
1	0	1
1	1	0

Figure 8C is the NAND gate truth table. The rules of operation for the NAND gate are:

1. A LOW on either input creates a HIGH output.
2. Both inputs must be HIGH for the output to be LOW.

We can see this same action in the equivalent circuit shown in Figure 8B. Recall our switch logic protocol: switch open is a LOW on the input, and switch closed is a HIGH on the input.

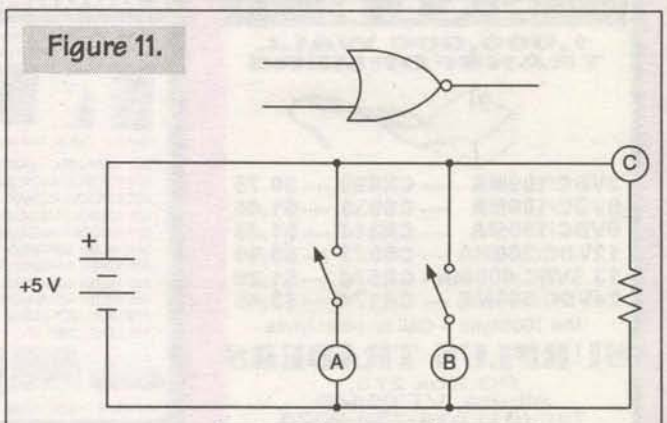
The voltage at point "C" will be HIGH if either switch A or switch B is open (either input is LOW). But if both switches are closed (both inputs are HIGH), then the load is shorted out and point "C" is LOW.

The NAND gate is one of the most popular gates used in digital electronics circuits. An example of a quad, two-input, TTL NAND gate is shown in Figure 9.

Recall that TTL is a current-sinking logic family, meaning that the output will sink (pass to ground) electrical current. The inputs of a TTL device form a 1.6-mA current source. Any traditional TTL input is considered HIGH when greater than +2.4 volts is applied, and must be held to less than 0.8 volts when LOW. This requirement means that any ground connection must have a resistance less than R = (0.8V)(0.0018A) = 440 ohms. If a higher ground resistance is encountered, or if a voltage between 0.8V and 2.4V is applied, then operation is undefined; all bets for proper operation are off.

A CMOS NAND gate IC such as the old 4011 device is shown in Figure 10. This device is also a quad two-input NAND gate. The 4011 requires only 0.4 mA per package (as opposed to 12 mA for TTL).

Figure 11.



A	B	C
0	0	1
0	1	0
1	0	0
1	1	0

NOR Gates

A NOR gate is the same as an OR gate with an inverted output. The NOR designation is derived from NOT-OR, and its operation is described by $\overline{A + B}$. The circuit diagram symbol for the NOR gate is shown in Figure 11A, and is the OR gate with a circle on the output to signify the inversion. The equivalent circuit is shown in Figure 11B and the truth table is in Figure 11C. The rules governing the NOR gate are:

1. A HIGH on either input produces a LOW output.
2. Both inputs must be LOW to make the output HIGH.

We can see this action in the circuit of Figure 11B. If either switch A OR switch B is closed, then the output "C" will be HIGH.

Figure 12 shows an example of a TTL NOR gate. This device is not often used anymore, but serves to illustrate the operation. This device contains four two-input NOR gates that can be used independently of each other.

Exclusive-OR (XOR) Gates

The Exclusive-OR, or XOR, gate is shown in Figure 13. Examine the truth table for the XOR gate below:

A	B	C
0	0	0
1	0	1
0	1	1
1	1	0

From this truth table, we may infer the rules of operation governing the XOR gate:

1. The input is LOW either if both inputs are LOW or both inputs are HIGH (i.e., both inputs the same).

2. The output is HIGH if either input is HIGH.

In other words, a HIGH on either input alone will produce a HIGH output, but a HIGH on both inputs simultaneously produces a LOW output. Any time we find all inputs of an XOR gate in the same condition (HIGH or LOW), then the output will be LOW.

Conclusion

Digital circuits are quite complex today, and form some terribly high level functions. But at their heart are the collection of gates discussed in this month's column. **NV**

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Figure 9.

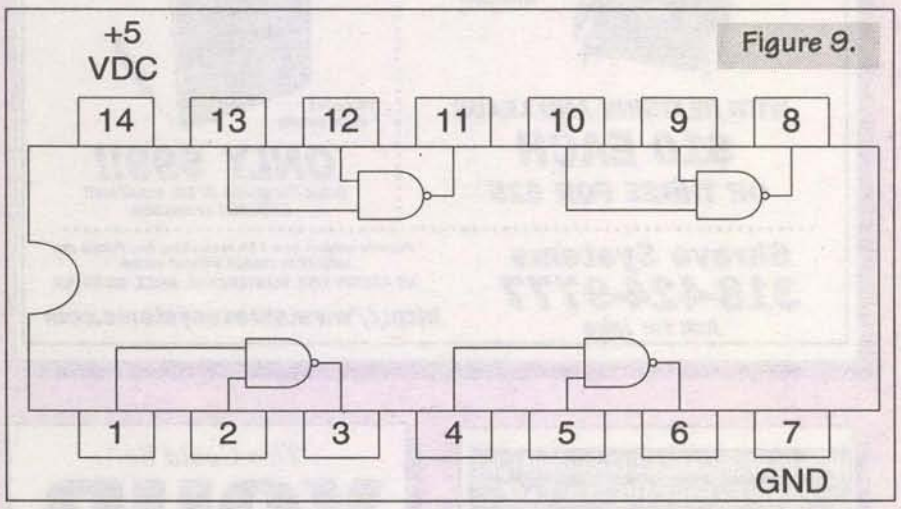


Figure 10.

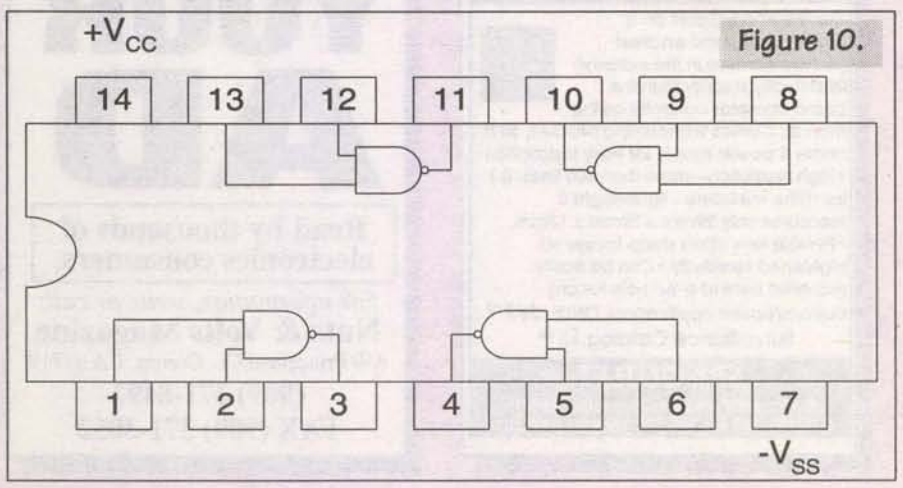
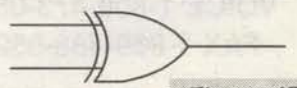
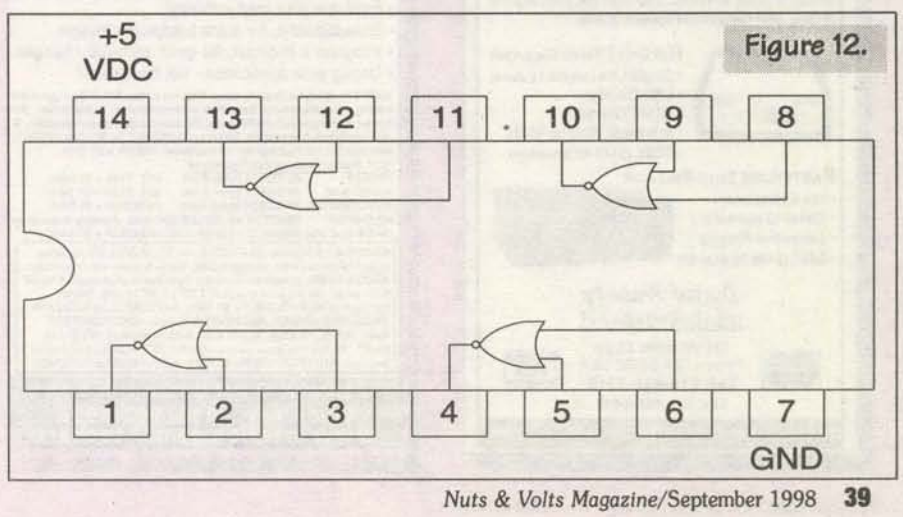


Figure 13.



A	B	C
0	0	0
1	0	1
0	1	1
1	1	0

Figure 12.



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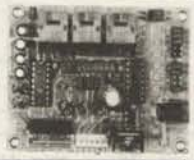

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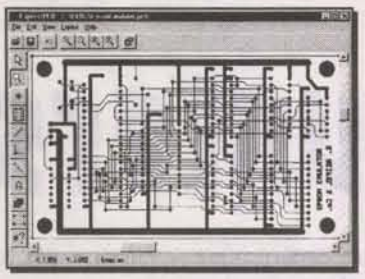

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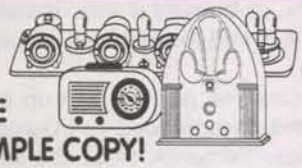

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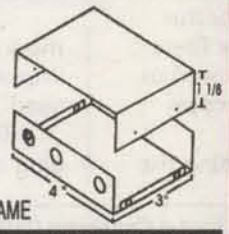

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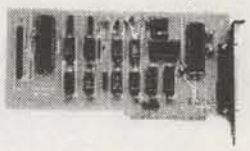

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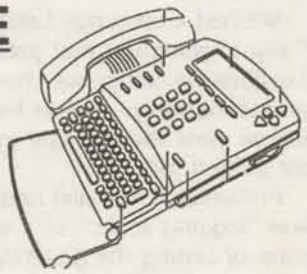

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by Fred Blechman

Digital Frequency Counters

Part 2

In Part 1 of this article on digital frequency counters, we described typical frequency counters, with details on the circuit used in the Sound Master SM-100 available from Mark V Electronics.

In this Part 2, we will detail some actual uses for the SM-100 and other frequency counters, and describe several units available from other sources.

Using the SM-100

First of all, we wanted to check the accuracy of the factory-assembled SM-100 against a known-accurate crystal timebase generator at 100Hz, 1KHz, 10KHz, 100KHz, and 1MHz. This involved using a scope probe plugged into the SM-100, and connected to the output and ground terminals of the timebase.

This timebase generated squarewaves, and we used an oscilloscope to monitor the signal applied to the counter to be sure there were no spurious signals. This also allowed us to check the frequency based on the scope timebase.

With the SM-100 turned on, and using the appropriate switch settings, the counter was "right on" to two decimal places at all five frequencies. This indicated the SM-100 timebase, which has an internal calibration control, was accurately set.

Since the top calibration frequency of 1MHz was relatively low, it did not insure accuracy beyond about four digits. However, since this was a digital unit using digital dividers, this indicated reasonable accuracy for higher frequency readings. To insure more accurate calibration, you could use a receiver tuned to the 25MHz transmission of the National Bureau of Standards Radio Station WWV, broadcast from Fort Collins, CO 24 hours a day. See any Radio Amateur Handbook for transmission details.

We had a six-range Lafayette SG-10 RF signal generator that probably needed calibration. When we checked various dial markings against frequency, it became clear that the dial markings were indeed "off."

Fortunately, the dial had a 0-100 linear "logging scale," so it was just a matter of setting the generator until the frequency counter showed the target frequencies as we moved up scale on each range, and then making a calibration chart. The result is shown in Chart 1.

We also determined that the audio frequency output of this generator, used for internal RF modulation, was 443Hz — not particularly important, other than it was not the "advertised" 400Hz.

Then we calibrated the dial using the logging scale of a four-range Lafayette TE-22 audio generator. We also had an Elenco FG-500 function generator that produced sine, square, and triangle waveforms, but the rotary "frequency" control and "X1/X10/X100" switch had no indication of frequencies. It was easy using the SM-100 to measure and then mark the minimum and maximum frequencies for each of the three switch positions.

Next, using a simple four-turn one-inch-diameter pick-up loop, we checked the actual transmitting frequencies of a Swan "Cygnet" 250 PEP "ham" transceiver on several bands up to 30MHz, to be sure it was operating within the legal allowed frequencies at each of the band edges.

In this case, we put the pick-up coil near an unshielded dummy load (a 60-watt light bulb) for measurements, since the actual antenna was on the roof. For handheld transceivers, the whip antenna is on the transceiver itself.

There was a significant difference between some Swan Cygnet transceiver dial readings and the actual transmission frequencies. This is especially important at the band limits for amateur radio transmissions.

Altogether, unless you have some special "shirt-pocket" requirements, or higher frequency counting than 150MHz, the SM-100 — sold assembled and calibrated for $99.00 — is a very good buy.

Lafayette SG-10 RF Signal Generator Calibration Chart — 7/23/96

BAND A		BAND B		BAND C		BAND D		BAND E		BAND F	
KHz	LOG	KHz	LOG	MHz	LOG	MHz	LOG	MHz	LOG	MHz	LOG
120	16.5	350	19.0	1.0	16.5	3.5	OK	11.0	OK	40.0	25.0
150	56.0	455	62.5	1.5	78.5	3.58	OK	15.0	OK	50.0	63.0
200	96.5	600	98.5	2.0	113.0	4.0	OK	20.0	94.5	60.0	85.5
250	127.5	700	118.0	2.5	139.0	5.0	OK	25.0	120.0	70.0	OK
300	OK	800	135.0	3.0	160.5	7.5	OK	30.0	140.5	80.0	117.0
N/A	N/A	900	150.0	N/A	N/A	10.0	OK	35.0	OK	90.0	130.5
N/A	N/A	1000	163.5	N/A	N/A	10.7	OK	N/A	N/A	N/A	N/A

N/A = Not Applicable

Chart 1: RF Signal Generator Calibration Chart

STARTEK ATH-15, ATH-30, and ATH-50 Frequency Counters

Frequency Ranges: Low: 5Hz-50MHz; High: 10MHz-2.8GHz
Display: Eight-digit .3" LED (multiplexed)
Gates: Low Range: .12, .48, 4.08; High Range: .08, .31, 2.62 sec.
Input Sensitivity: 5Hz-1MHz, 8mV
10-800MHz, under 2mV
1GHz, 5mV
2GHz, 10mV
2.4GHz, 25mV
Timebase: ±1 ppm. Premium timebase upgrade available.
Accuracy: ±1 digit, ±1 ppm timebase
Input Impedance: Low Range: 1MΩ; High Range: 50Ω
Response Time: 80ms with ATH feature
Resolution: 1Hz at 4.08 second gate time
10Hz at .48 second gate time
100Hz at .12 second gate time
100Hz at 2.62 second gate time
1KHz at .31 second gate time
10KHz at .08 second gate time
Price: $339.00
Hold: Holds the last input signal
Power: 9-12VDC power adapter (300mA); internal Ni-Cds
Dimensions: 4" high, 3.5" wide, 1" thick

Table 1: STARTEK ATH-50 Technical Specifications

Other Frequency Counters

Some digital multimeters (DMMs) come with a frequency counting function, although they are generally limited in their maximum reading. EXTECH's $89.00 A380278 Rangemaster II+ DMM includes a frequency counter function with a maximum range of 20MHz, while Elenco's $125.00 data-logging Model M-6100 DMM with computer interface has a frequency counter function that has an upper limit of only 200KHz.

Although various frequency counter manufacturers offer some devices for general use, others specialize. For example, Optoelectronics — in addition to general-use counters — specializes in nearfield

receivers and unique items for scanner users. Startek specializes in small, portable, high-sensitivity, high-accuracy digital LED counters for testing and calibration. Weeder makes a unit you can put inside another instrument, such as a signal generator, for direct frequency readout. TechAmerica offers various multi-function bench-type frequency counters.

There are far too many manufacturers and models of frequency counters to cover here, but we'll look at some typical units from various manufacturers. For more information on other counters, contact the individual manufacturers listed under the SOURCES sidebar.

STARTEK "ATH™" Series Frequency Counters

At the higher end of the frequency counter world, STARTEK manufactures a broad line of factory-assembled counters starting at about $120.00. Most are sub-compact, pocket-size units, designed for ease of use and dependable performance.

The line of "ATH" counters include the ATH-10, ATH-15, ATH-30, and ATH-50. "ATH" refers to the new and unique high speed "Auto Trigger & Hold" circuitry that is standard on all STARTEK ATH series frequency counters. This new and highly significant feature enables the reading of very short signals (80 milliseconds or longer), and also includes an automatic clean dropout function that prevents a false display when a signal stops amid a sample count.

The Response Time, or time from the start of an input signal until the frequency is displayed, has been significantly reduced. The ATH series counters are about 10 times faster than their predecessors, and have top ranges of from 1.2GHz (gigaHertz — thousands of megaHertz) to 2.8GHz!

The Auto Trigger & Hold feature, and Fast Response Time dramatically change the way these instruments can be used. For example, these shirt-pocket counters can be used near communication transceivers used in casinos, or by crowd controllers at major events, to determine transmission frequency, thus allowing you to set your scanner to the proper frequency range for reception.

The eight-digit 0.3-inch high multiplexed LED display characters are especially bright, making it readable outdoors except in direct sunlight. These are shirt-pocket size units that can be held in the hand, and weigh only about nine ounces. The black anodized

Input Sensitivity *(Typical)*

Amplifier	50 Ohm
Impedance	50 Ohm, VSWR<2:1
Range	1MHz-2.8GHz
Sensitivity	<0.8mV@100MHz
	<6mV@250MHz
	<7mV@1GHz
	<100mV@2.4GHz
Maximum Input	15dBm

Table 2: ELENCO F-2800 Technical Specifications

Frequency Display Resolution

Range	Gate Time	LSD	Sample Display
250MHz	0.0625 Sec	10Hz	250.00000MHz
	0.25 Sec	1Hz	250.000000MHz
	1 Sec	1Hz	250.000000MHz
	4 Sec	0.1Hz	250.0000000MHz
2.8GHz	0.0625 Sec	1000Hz	2800.000MHz
	0.25 Sec	100Hz	2800.0000MHz
	1 Sec	10Hz	2800.00000MHz
	4 Sec	10Hz	2800.00000MHz

RF Signal Strength Bargraph

Frequency	1st Segment	Full Scale
27MHz	7mV	100mV
150MHz	5mV	90mV
800MHz	10mV	200mV

Cabinet: Extruded aluminum, black paint finish
Display: 10 digit liquid crystal display (LCD)
Size: 80mm high * 68mm wide * 32mm deep
Weight: 220g
Battery: Internal 4AA 600mAH NiCd battery pack
Power: 9VDC, 500mA wall plug adapter
Timebase: <1PPM typical at room temperature

ELENCO F-2800 Frequency Counter

OPTOELECTRONICS CUB MiniCounter

Frequency Range	1MHz-2.8GHz
Input Impedance	50 Ohm
Input Coupling	AC
Max Input	+15dBm (50mW)
Timebase	Frequency: 10MHz
	Initial Accuracy ±1PPM

Frequency Display Resolution (*Least significant digit displayed (LSD) as a function of Gate and Range.)*

Range	Gate Select	Gate Time	LSD	Sample Display
250MHz	1	.0001 Sec	10KHz	250.00
	2	.001 Sec	1KHz	250.000
	3	.01 Sec	100Hz	250.0000
	4	.1 Sec	10Hz	250.00000
	5	1.0 Sec	1Hz	250.000000
2.8GHz	1	.0064 Sec	10KHz	2800.00
	2	.064 Sec	1KHz	2800.000
	3	.64 Sec	100Hz	2800.0000

Input Sensitivity (*Typical*)

10MHz	<15mV	**800MHz**	<3mV
27MHz	<2mV	**1GHz**	<3mV
150MHz	<2mV	**2GHz**	<25mV
450MHz	<3mV	**2.4GHz**	<100mV

Table 3: Optoelectronics CUB MiniCounter Technical Specifications

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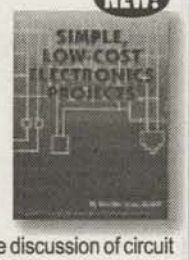

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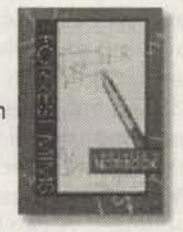

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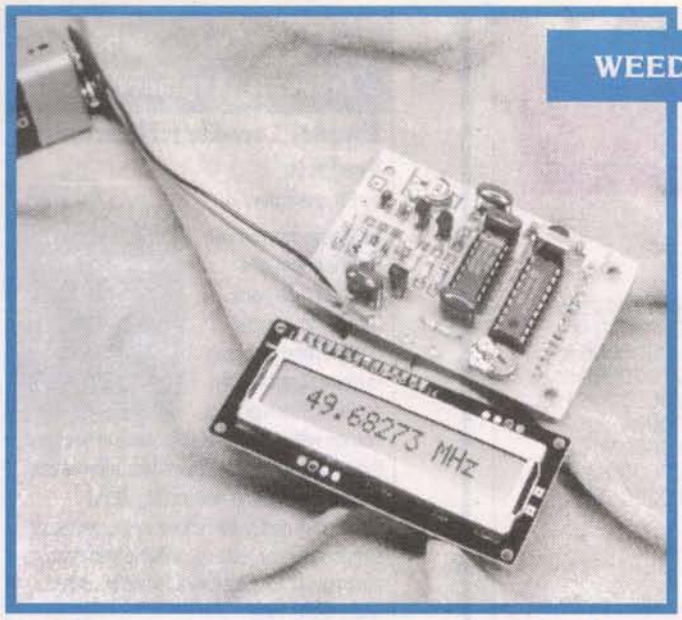


WEEDER 50MHz Frequency Counter

aluminum case measures 4-inches high, 3.5-inches wide, and 1-inch thick. The specifications for the ATH-50 (top of the line) are shown in Table 1.

Using the STARTEK ATH-50

An excellent 30-page User's Manual is included with the ATH line of frequency counters. We tested the ATH-50 and found it small and easy to use — though it took some study to properly set the five slide switches and one pushbutton switch, and interpret the five tiny LED indicators.

A full line of accessories (vinyl case, various antennas, and probes) is available, as well as band pass filters, making this an exceptionally versatile unit. Ni-Cad batteries (factory installed) power the unit, and an external adapter is included for AC power and recharging the batteries. A two-inch 10-segment red LED bar graph indicates relative signal strength. This unit has too many features to describe in this report; if you are interested, contact STARTEK for details.

We made the same frequency measurements as with the SM-100, with identical results when the various switches were set properly. The ATH — automatic trigger and hold — feature was especially useful when measuring the output of a transmitter, since it did not have to be turned on for more than a couple of seconds to capture the frequency on the display.

Elenco Frequency Counters

C & S Sales is the mail order distributor for Elenco products, as well as various other manufacturers, such as Fluke and B&K, who make frequency counters or include a frequency counter function in other instruments. At the time this is being written (Spring 1998) two Elenco frequency counters are offered.

The Model F-1300 1.3GHz universal counter sells for $225.00. It is a line-powered benchtop unit that has nine 0.56-inch high green digits for a readout, and counts in three ranges down to 0.05Hz. I did not test this unit, and its many features are intended for professional use.

The Model F-2800 is a handheld unit that measures from 1MHz to 2.8GHz and sells for only $99.00. In this small 3.2-inch high by 2.7-inch wide by 1.2-inch thick case, Elenco has managed to cram a 10-digit LCD display (with 0.3-inch high digits); six-hour Ni-Cad rechargeable batteries; a GATE button (with a blinking LED to indicate gate time); a HOLD switch; a two-range switch; and a power switch. The display includes a sensitive 16-segment bargraph indicating relative signal strength.

A supplied telescoping whip antenna connects to the unit's BNC connector, and an AC wall adapter — which is used as a converter and battery charger — is also included. The specifications of the F-2800 are shown in Table 2.

Using the Elenco F-2800

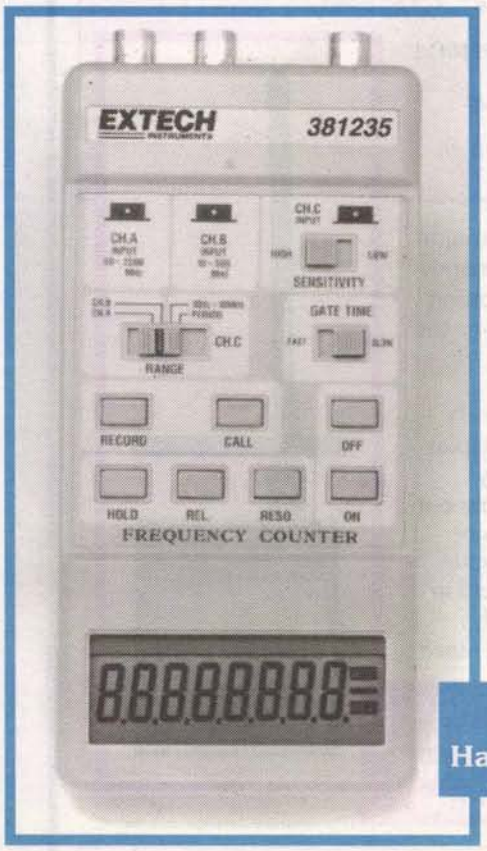
A small 16-page User's Manual describes the F-2800 features, specifications, controls, and usage. We put the F-2800 through many of the same tests described for the SM-100 and the STARTEK ATH-50 described earlier.

The unit is very easy to use; just turn on the power switch and a red LED immediately starts blinking rapidly to indicate a very fast gate time. Press the GATE key again and the time slows to about 0.3 seconds. Press GATE again and the gate time drops to about one second. Press GATE again and the gate time is five seconds.

The only other switch to set is the range switch. The lower position measures from 1MHz to 250MHz. The upper position reads from 10MHz to 2.8GHz. Press the HOLD button anytime to "freeze" the last reading, and press it again to continue.

Since the lower range of the F-2800 is 1MHz to 250MHz, we could only verify the maximum 1MHz output of the crystal timebase generator. We could not test the audio oscillator at all, since its maximum frequency output was 200KHz.

The RF generator tests went well with the



EXTECH Model 381235 Handheld Frequency Counter

Specifications:		381200	381235
Range (Frequency):	Channel A:	10MHz to 1250MHz	50MHz to 2500MHz
	Channel B:	10Hz to 10MHz	10MHz to 500MHz
	Channel C:		10Hz to 10MHz
	Period:	10Hz to 10MHz	10Hz to 10MHz
Minimum Resolution:		0.1Hz	0.1Hz
Sensitivity:	Channel A:	10-150mV rms	Channel A,B,C, <50mV rms
	Channel B:	<50mV rms	
Input Inpedance:	Channel A:	50Ω typical coupled	Channel A&B: 50Ω typical
	Channel B:	1MΩ/30PF typical AC coupled	Channel C: 1MΩ/30PF typical AC coupled
Maximum Overload Protection:	Channel A:	5V peak to peak	Channel A&B: 5V peak to peak
	Channel B:	250V peak to peak	Channel C: 250V peak to peak
Timebase Circuit:	4.194MHz quartz crystal		
Connector:	BNC		
Consumption:	Ch A 100mA; Ch B 45mA		Ch A&B: 105mA; Ch C 45mA
Dimensions/Weight:	6.8x3, 1x1.4" (173x79x36)/12 oz.		

Table 4: EXTECH K381200 and K381235 Technical Specifications

SOURCES

Sound Master SM-100 is available in kit form for $79.00, or assembled and tested for $99.00, from **Mark V Electronics, Inc.,** 8019 E. Slauson Ave., Montebello, CA 90640. 24-page illustrated catalog (almost 50 electronic kits or assembled units) and information: (213)888-8988. Orders only: In California (1-800) 521-MARK; outside California (1-800) 423-FIVE; Fax (213) 888-6868. Call them for for shipping, handling, and sales tax. Internet: www.mark5co.com ; E-Mail: mark5co@aol.com.

STARTEK International, Inc., 398 Northeast 38th St., Fort Lauderdale, FL 33334. Orders: (1-800) 638-8050. Information: (954) 630-1511. Fax: (954) 561-9133. Call them for colorful brochures and price list.

Elenco frequency counters are available from **C & S Sales, Inc.**, 150 W. Carpenter Ave., Wheeling, IL 60090. Orders: (1-800) 292-7711. Inquiries: (847) 541-0710. Fax: (847) 541-9904. Call for 64-page catalog full of kits and assembled instruments. Internet: www.elenco.com/cs_sales; E-Mail: elenco@elenco.com.

Weeder Technologies, P.O. Box 2426, Fort Walton Beach, FL 32549. Orders or information: (850) 863-5723. Call for free catalog of 15 "Pro-Kits."

Optoelectronics, Inc., 5821 N.E. 14th Ave., Ft. Lauderdale, FL 33334. Orders: (1-800) 327-5912. Inquiries: (954) 771-2050. Fax: (954) 771-2052. Internet: www.optoelectronics.com; E-Mail: sales@optoelectronics.com.

EXTECH Instruments Corp., 335 Bear Hill Road, Waltham, MA 02154-1020. Phone (617) 890-7440; Fax (617) 890-7864. Full-color 44-page catalog of instruments for test, measurement, calibration, and control of electronic equipment. Internet: www.extech.com; E-Mail: extech@msn.com.

TechAmerica, P.O. Box 1981, Fort Worth, TX 76101-1981. No minimum order, $4.00 total shipping in most cases. Orders: (1-800) 877-0072. Fax: (1-800) 813-0087. Support: (1-800) 876-5292. Internet: www.techam.com.

output lead of the generator clipped directly to the F-2800 whip antenna. Similarly, still using the whip antenna, we could measure the frequency output of the ham transceiver to a dummy load on all of its five frequency bands from 3.5MHz to 29.7MHz.

Weeder Technology Frequency Counter

The lowest-price frequency counter we found was the 50MHz Frequency Counter available in kit form ($46.00) or assembled ($66.00) from Weeder Technologies. This pre-programmed PIC16C54 microcontroller-based design has a small parts count and the two-sided etched circuit board is only 3-inches by 2-inches. The display board is 3-inches wide and 1.5-inches high.

It reads frequency from 1Hz to 50MHz on an LCD seven-digit readout with 0.2-inch high digits. No cabinet is provided, so its use can be customized. For example, since it is relatively small, it could be integrated into a signal generator to display a digital frequency readout.

A really neat feature is that, except for an on/off switch, there are no other switches or buttons. An auto-range feature provides a floating decimal point and automatic display of the units — Hz, KHz, or MHz. The gate speeds of 0.1 second or one second also adjust automatically.

Using a standard 9V battery for power, the input sensitivity is approximately 100mV RMS for 100Hz to 2MHz, increasing to about 800mV RMS at 50MHz.

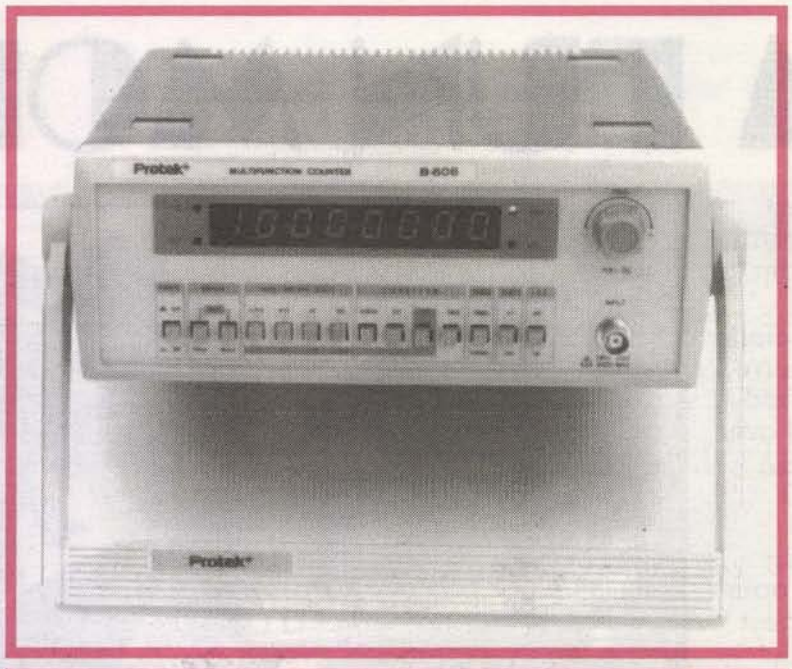
Detailed six-page instructions include a schematic and parts layout. Circuit operation is explained in detail, followed by assembly and calibration information.

We had no trouble calibrating the unit and, using a direct connection to the device under test, we were able to check all ranges of the crystal timebase generator, all ranges of the AF generator, and all ranges of the RF generator. Using a pick-up loop, we were able to calibrate all bands of the ham transceiver. This counter is very useful if you will not be counting above 50MHz, or want to add it to an existing instrument for frequency readout.

Optoelectronics Frequency Counters

A large selection of frequency counters are available from Optoelectronics, from the $99.00 micro counter to the $999.00 multifunction counter/timer. Computer interfaces, filters, software, and various accessories are described in their 20-page full-color catalog.

We did not test any Optoelectronics units, but received information on several. For example, the CUB MiniCounter ($149.00) is an RF counter intended for two-way communications testing. Its technical specifications are shown in Table 3.



PROTEK Model B-808 Multifunction Counter

FREQUENCY MEASUREMENT

Range: 10Hz to 10MHz Direct
10MHz to 100MHz prescaled
Resolution:
Direct: 0.1Hz, 1Hz, 10Hz, 100Hz
range dependent
Prescaled: 1Hz, 10Hz, 100Hz, 1000Hz
Gate Time: 0.01S, 0.1S, 1S, 10S
Accuracy: ±1 count ±(timebase error) X frequency

PERIOD MEASUREMENT

Range: 10Hz to 2.5MHz
Period Multiplier: X1, X10, X10, X1000
Resolution: 0.1nS, 1nS, 10nS, 100nS
Accuracy: ±1 count ±(timebase error) X period

INPUT CHARACTERISTICS

Sensitivity: (ACRMS)
10MHz Range: 10Hz to 8MHz: 25mV
8MHz to 10MHz: 50mV
100MHz Range: 10MHz to 80MHz: 25mV
80MHz to 100MHz: 50mV
Attenuation: X1 or X20
Input Impedance: 1MΩ (C=<35pF)
Lowpass Filter (-3dB):
10Hz to 100KHz
Max. Voltage: 250V (DC + AC peak)
Trigger Level: 0 to ±350mV

TOTALIZE MEASUREMENT

Frequency Range: 10Hz to 100MHz
Count Capacity: 0 to 99,999,999
Resolution: ±1 input count

TIMEBASE

Frequency: 10MHz (Oven controlled)
Stability:
Long Term: $\pm 2X10^{-5}$ per month
Temperature: $\pm 1\ X10^{-5}$ 0°C to 40°C
Line Voltage: $\pm 1X10^{-7}$ for 10% change

GENERAL SPECIFICATIONS

Power Requirements:
AC Line Voltage: 100 to 240V ±10%
Input Power: Approx 10VA
Size & Weight: 3"HX8"WX10-1/2"D; 5 lbs.
Accessories: Power cord, manual

Table 5: PROTEK Model B-808 Technical Specifications

Measuring only 3.7-inches high, 2.8-inches wide, and 1.2-inched deep, it covers a frequency range of 1MHz to 2.8GHz in two ranges with eight selectable gate times. A patented feature called Digital Filter eliminates random counts, so only real measurements are displayed, and the patented Auto Capture feature displays each captured frequency until cleared.

The liquid crystal display (LCD) has nine 0.175-inch high digits, plus various display annunciators. The internal Ni-Cad rechargeable batteries power the unit for 10 hours. An AC adapter/charger is supplied with the unit. The DB32 VHF/UHF antenna, not included, is another $29.00.

EXTECH Frequency Counters

A source for handheld portable frequency counters is EXTECH Instruments. They measure 6.8-inches high, 3.1-inches wide, and 1.4-inches thick. Two models are available: the Model K381200 ($209.00) counts from 10Hz to 1.25GHz in two ranges; the Model K381235 ($249.00) reads from 10Hz up to 2.5GHz in four ranges. Eight-digit 0.5-inch LCD displays are used, and accessories (case, AC adapter, probe, antenna) are available. The specifications for both counters are shown in Table 4.

These counters have a sensitivity of less than 50mV (millivolts). Portability and the optional telescoping pick-up antenna make it ideal for verifying RF transmitter frequencies. Relative frequency measurements make it suitable for repair shops. Features include Data Hold and Overload indication, Max/Min and Average readings, selectable Fast/Slow gate time, and Auto/Manual power off. They are powered by four (included) 1.5 volt AA batteries. We did not receive units to test, but they seem to have some deluxe features. Contact EXTECH for details.

TechAmerica Frequency Counters

Relatively new on the electronics-resources scene, TechAmerica is not a manufacturer, but a large distributor of everything electronic. They carry various lines of test equipment, including frequency counters made by Leader, Wavetek, and Protek. The least expensive frequency counter they carry is the benchtop Protek Model B-808 10Hz to 100MHz multifunction counter, which sells for $215.00. The specifications are shown in Table 5.

We were not supplied a unit for testing, but the description in TechAmerica's recent 560-page full-color catalog indicates the Protek Model B-808 (Catalog Number 910-0418) measures 3-inches high, 8-inches wide, and 10.5-inches deep, with frequency, period, and totalize functions displayed using an eight-digit LED readout. (Totalize measures the number of cycles counted in a discrete time.) Four gate times (0.01 to 10 seconds) can be selected. It operates from AC line voltage; a power cord and BNC-to-alligator-clip signal cable are included.

Summary

While this two-part article on frequency counters has not attempted to cover the entire field — either from a technology or availability sense — we have attempted to briefly describe some of the available units and their capabilities.

If your budget is tight and your counting needs embrace audio frequencies up to low RF frequencies, then the Weeder Technologies 50MHz Frequency Counter might be a good choice — but you'll have to mount it into a cabinet or an instrument case.

For handhelds, the Elenco F-2800 frequency counter seems to offer the most for the lowest price if your counting needs do not go below 1MHz.

For a bench-type unit, it's hard to beat the Sound Master S-100 from Mark V Electronics for versatility and low price — but buy it assembled, not as a kit! NV

ICOM FUN MOBILE

The Icom Fun Mobile, the largest radio station on wheels, left Icom America on April 3, '98 to begin its year-long tour of North America.

The Fun Mobile, heading south along the western coast, across the southern states and north through the east, mid-west states, and Canada has visited over 26 states and two provinces with 182 destinations including 126 cities, 10 hamfest, and 43 radio clubs.

Icom's Fun Mobile, a 30-foot long motor home outfitted with multiple operating radio stations, received its largest attention at the Dayton hamfest with over 25,000 radio users in attendance.

The Fun Mobile has received numerous praises from its audiences that exclaim, "This van is amazing. I wish I could borrow it," Justine Marrese N1TZD. "Well presented and professionally explained," Bill Curtis K2BIL. "Well worth running after!" Kenneth G. Ranson N5VHO. And even being flagged over to the side of the road in California by an avid radio user.

Unique in its own, the Fun Mobile is also searching out and going where it has not gone before. As well as the major city visits, the Fun Mobile is stopping in some smaller communities and special events, such as The National Science Center (NSC) Fort Discovery in Augusta, GA. Sponsored by the US Military, this science center educates and fascinates kids with science. Joining this effort of science awareness for kids, Icom is honored to display today's radio communication technologies.

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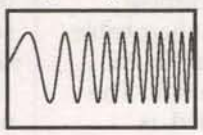
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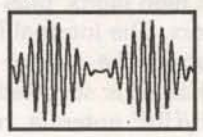
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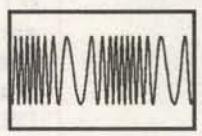
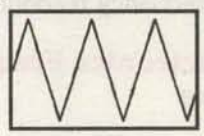
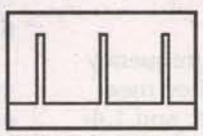
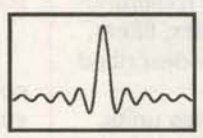
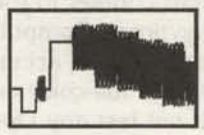

Int/Ext FM, PM, BPSK, Burst


Ramps, Triangles, Exponentials


Pulse Generator

Noise


Arbitrary Waveforms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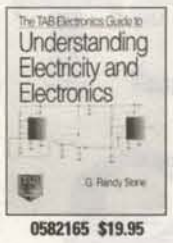

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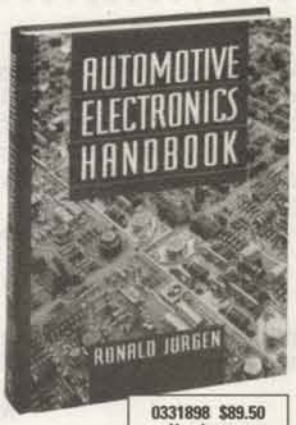

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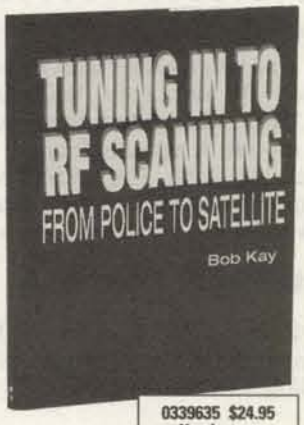

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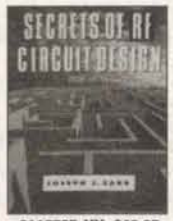

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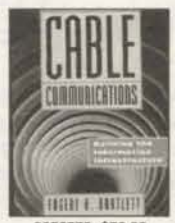

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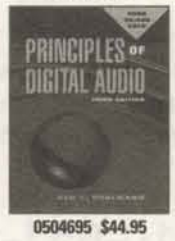

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ELECTRONICS Q & A

With TJ Byers

In this column, I answer questions about all aspects of electronics, including computer hardware and software. This column doesn't replace the Tech Forum that you've grown to love and support. Instead, it will supplement it, so feel free to participate as always with your questions and answers. You can send your questions to me by E-Mail at q&a@nutsvolts.com, or by snail mail at Nuts & Volts Magazine, 430 Princeland Ct., Corona, CA 91719.

What's Up:

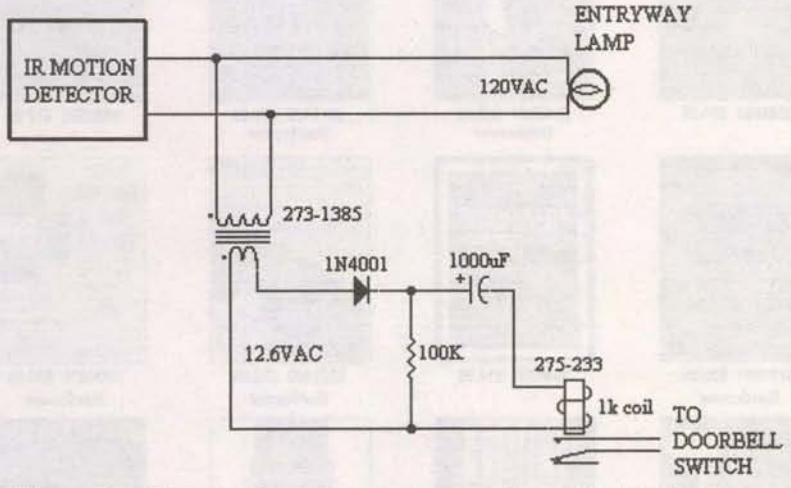
Are you familiar with the 4-20mA standard which is making a comeback in PC interfaces? You will when you read "The 4-20mA Current Loop Still Lives." Calibrating the 4-20mA loop is also the first of three circuits this month. A remote doorbell and 300-MHz frequency doubler round out the circuit circle. The LM558 rediscovered, and more on the 555. How to computerize your home, and an update on atomic clocks

Automatic Doorbell

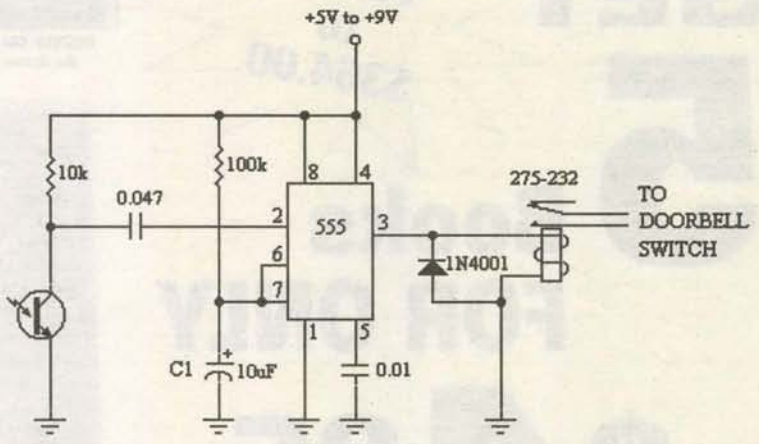
Q. I have a motion-controlled IR light on my entranceway, and I was wondering if there was a simple relay or circuit that I could use to actuate an existing 12-volt doorbell?

Mike Sheridan
via Internet

A. *There are a couple ways this can be done, depending on your access to the AC wiring. If you can tap the lamp's wiring, here's the circuit you want.*



When the IR controller actuates, power is applied to the transformer which charges the 1000uF capacitor. The charging current causes the relay to pull in for about two seconds and actuate the doorbell. You can adjust the time the doorbell button is "pressed" by increasing or decreasing the size of the capacitor. When the light goes off, the capacitor discharges through the 100K resistor. If you can't tap into the AC wiring, here's another way you can trigger off the IR controller using a light-sensitive sensor.



In this design, you position the phototransistor close to the entryway lamp so that it triggers when the bulb lights – and not from the rising sun. Again, the time the relay contacts are closed can be adjusted by increasing or decreasing the value of C1. If you use the CMOS version of the 555 (Radio Shack 276-1718), a 9-volt battery will power this circuit for many months.

The 4-20mA Current Loop Still Lives

Q. I need a circuit to calibrate 4-20mA control loops. The test voltage has to be at least 9 volts and the instrument must be small enough to fit into a small, handheld box. Ideally, the calibration current would cover the entire 4mA to 20mA range. I know of a commercial unit that uses a 9-volt battery to test the loop, but it eats up batteries at an unacceptable rate. What do you suggest?

Tom P.
via Internet

A. *First, let me explain to our readers what a 4-20mA control loop is. Basically, it's a method that's been used for years to transmit information from one site to another – typically from a remote sensor to a local receiver. There are many ways to input analog voltages into controller and display devices. The one that most readers know best is the 0- to 5-volt method that has been popularized by the computer. Let's say you have a remote thermometer that is calibrated for 0 to 100 degrees, where 0°C = 0V and 100°C = 5V. But what happens if the temperature drops below freezing, or there's a break in the connection? Your controller will assume it's 0°C all the time because there is no way to represent less then zero. One way to solve the problem is to calibrate the sensor so that 1V equals 0°C and 5V is 100°C. Still,*

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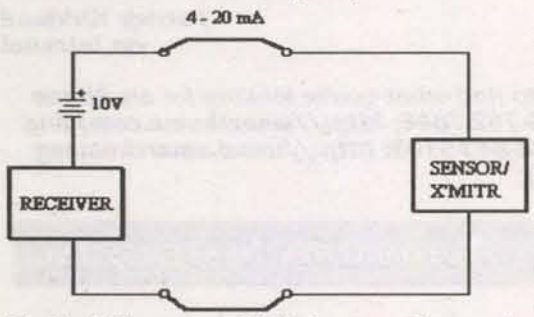
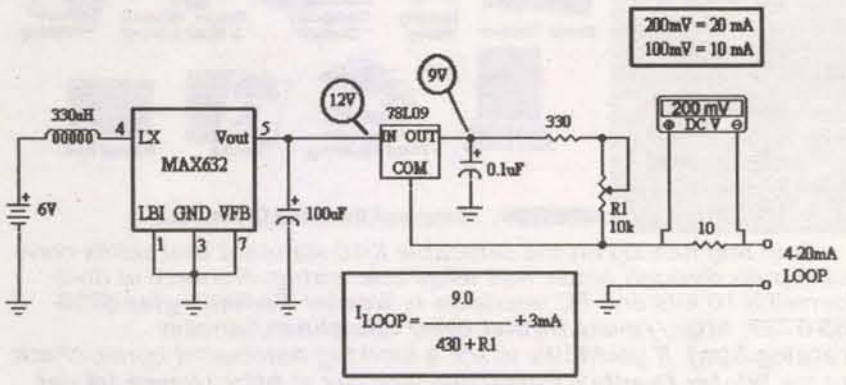
Write in 53 on Reader Service Card.

though, we have the problem of voltage loss in the connecting wires. What starts out as 4.44 volts may arrive as 3.99 volts – due to wiring resistance. Here's where the 4-20mA standard comes in. Instead of using voltage to send information from the sensor to the receiver, a current circles through a two-wire loop that connects the two. (This is exactly the same method the phone company uses to connect your phone with the central office.)



This current remains constant regardless of the wire losses by adjusting the source voltage up or down to maintain the desired current. To prevent the zero-current syndrome from happening, a 4mA current represents the low end of the scale. Using the example above, 0°C = 4mA and 100°C = 20mA. If the current falls to zero, the receiver senses that the loop is broken and acts accordingly. But that's not the only reason the 4-20mA standard is so popular. Remember that there's always at least 4mA of current flowing in the loop – current that can be tapped to power the sensor's electronics (this is called a loop-powered transmitter). What the reader wants to know is how to calibrate these set points using a simple, portable instrument. Here's how:



This instrument is divided into three parts. First is a current regulator made of an LM78L09 voltage regulator. Confused as to how a voltage regulator can regulate current? Look at the circuit, and notice that the GND doesn't go to ground, but instead is attached to the bottom of R1, which is in series with a 330-ohm resistor. Now it's the nature of a voltage regulator to maintain a constant voltage across the load, regardless of the current the load may draw. If that load is fixed, though, so is the current. That's the secret to current regulation, placing a fixed resistance between the OUT and GND legs and letting GND float above ground. The "real" load is now connected between the GND pin and ground to complete the circuit. The current through this path is equal to the output load current plus a small operating current (about 3mA) used by the linear regulator. The value of the resistor combination is selected to span the range of 4mA to 30mA, with a voltmeter (part two) monitoring the voltage across the 10-ohm resistor. When the meter displays 200mV, the current flow is 20mA; a 40-mV reading represents 4mA. The voltmeter can be a cheap panel meter or a DMM. The third part has to do with the power source, which is generated by a MAX632 DC/DC step-up inverter. Quickly, the 330uH inductor provides a high voltage "kick" to the 100uF Vout capacitor – an inductive or "flyback" kick that boosts the output to 12 volts. I opted for this design because of space limitations: four batteries take up a lot less room than eight. Furthermore, this chip is very forgiving because the input voltage can vary from 4 volts to 10 volts and still maintain a 12-volt output. Four AA cells will power this tester for many weeks.

MC13135 Update

Q. Got your magazine for the first time and I really enjoyed it, particularly the information in the May '98 column about the MC13135. I went to Motorola's Web site and got all the information I could, then I tried to find the part at Digi-Key and others with no luck. So I was wondering if you know of a source for the MC13135? I plan to use it with the PC-VFO that I purchased from an advertisement in your magazine, which has 1 Hz to 54 MHz range, so it should work with the MC13135 to give me some scanner capability. But I'd also like to scan higher (up to the Weather Radio at 162.4MHz). I'd planned to make a frequency quadrupler from an NE602, which I can't find either, and was wondering if you know of a circuit (perhaps using a PLL) which would do the same thing?

Martin Kempton
Edmonton, Alberta, Canada

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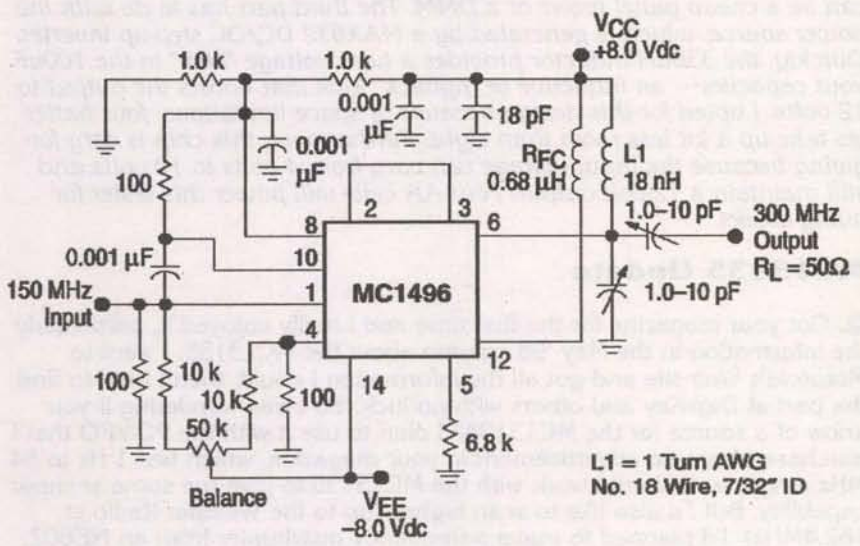
Write in 54 on Reader Service Card.

A. *You've taken on a very ambitious project, and I wish you luck. You can buy the MC13135 from* ***Allied Electronics (800-433-5600; http://www.allied.avnet.com)*** *for $3.62 or* ***Newark Electronics (800-463-9275; http://www.newark.com)*** *for $6.10. However, both have a minimum order that exceeds the cost of the IC, so plan ahead by adding other staples to the order, such as capacitors, resistors, etc. The NE602 is a now made by Philips Semiconductors under the guise of SA602A. You can find its datasheet on the* ***QuestLink*** *Web site at* ***http://www.questlink.com****. Like the MC13135 IC, the SA602A is available from both Allied Electronics and Newark Electronics (who lists it as NE602A). However, this chip isn't a frequency multiplier. Instead, it's a double-balanced mixer and oscillator. A better choice is the MC1496 or MC1596 modulator/demodulator. When configured as below, this chip will double the input frequency up to 300 MHz.*

150 to 300 MHz Doubler



The output contains the sum component, which is twice the input frequency because both signals are the same frequency. For 160-MHz operation, you'll need to tinker with the values of the tuned output circuit — specifically, increasing the value of the inductors (by adding turns, in one case) and perhaps padding the trimmer capacitors. For quadrupler operation, two MC1496 can be cascaded, just make sure you adjust the tuned circuits for their representative frequencies. Like the SA602A, you can download a datasheet for the MC1496 from QuestLink.

The Automated House

Q. Can you direct me to where I would start looking for a system to monitor home environment and security on my PC? What I'm looking for is hardware to accept input and interface to a PC. Then an interface to feed output back to hardware to flip switches. For example, the PC would monitor room temperature via a digital input, then decide to turn on the heater or air conditioner to maintain a certain temperature. Another example is a security device, like a motion detector, that would sound a burglar/fire alarm.

Patrick Kirkland
via Internet

A. *Two really great places to find what you're looking for are* ***Home Automation Systems (800-762-7846; http://smarthome.com)*** *and* ***Smart Home Systems (888-843-9103; http://www.smarthomesystemsusa.com/index.htm)****.*

Both rely heavily on the venerable X-10 standard that sends control signals through house and telephone wiring. A source of do-it-yourself X-10 kits and PC interfaces is ***Weeder Technologies (850-863-5723; http://www.infinet.com/~dhoehnen/weeder/catalog.htm)****. If you'd like to see a working automated home, check out the* ***Winter Family's*** *interactive Web site at* ***http://www.isl.net/~winter/house/programs/Welcome.html****. This site also contains information on how to write your own X-10 software routines.*

Do Antique Phones and PC Modems Mix?

Q. Do you have information regarding the effect of multiple telephones, especially the old "electric" ones, on the same line as a modem? By electric I mean those with a large capacitor and the ringer inductance common on older telephones. It seems that they would load the line resulting in slower modem performance.

Frank Wildeboor
via Internet

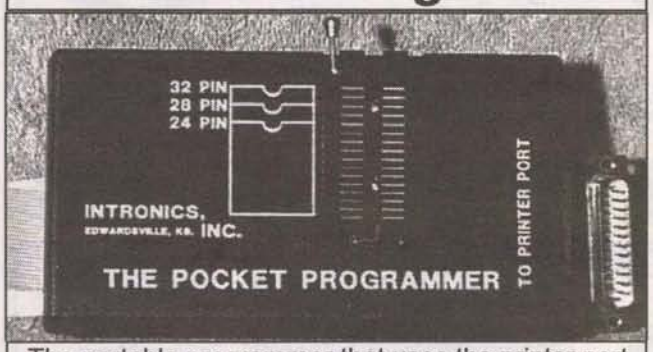
A. *I don't think an electric phone has much effect on a modem's performance. Why not? Because the modem has to work within the same bandwidth as a voice phone call, which is 300Hz to 3KHz, and increasing the number of on-hook electric phones doesn't affect the quality of the voice so why would it affect the modem? The way a modem achieves its high data rates is by using clever modulation techniques, not by increasing the carrier frequency.*

Win 95, from C to D

Q. In the Jan. '98 issue you described a procedure for copying files from the old C drive to a new D drive. I can copy the files okay, until I try to copy c:\msdos.sys d:\. All I get is "File not found." The MSDOS.SYS file on my old C drive is 1646 bytes, but the XCOPYed file is just nine bytes. I wonder if the read-only attribute should be removed from MSDOS.SYS to allow the copy command above to work?

Lloyd Roberts
via Internet

The Pocket Programmer



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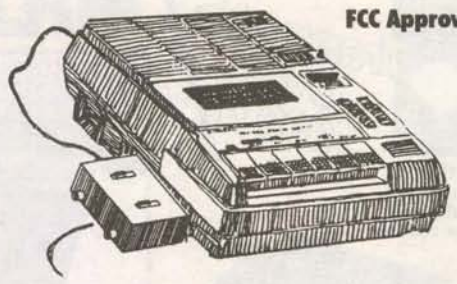

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Write in 55 on Reader Service Card.

A. Yeah, this turned out to be a problem for more than a few readers. Windows 95 has many hidden files, one of which is MSDOS.SYS. If you follow the instructions of the XCOPY32 transfer routine outlined in the Jan. '98 column, everything should end up in the right place – except for MSDOS.SYS. In most cases, a simple Win 95 COPY command works, but not always. For whatever reason, it sometimes has to be done from the DOS prompt. If you, like Mr. Roberts, are having problems copying this file, try this DOS routine.

```
ATTRIB -R -H MSDOS.SYS
COPY MSDOS.SYS d:
ATTRIB +R +H MSDOS.SYS
D:
ATTRIB +R +H MSDOS.SYS
```

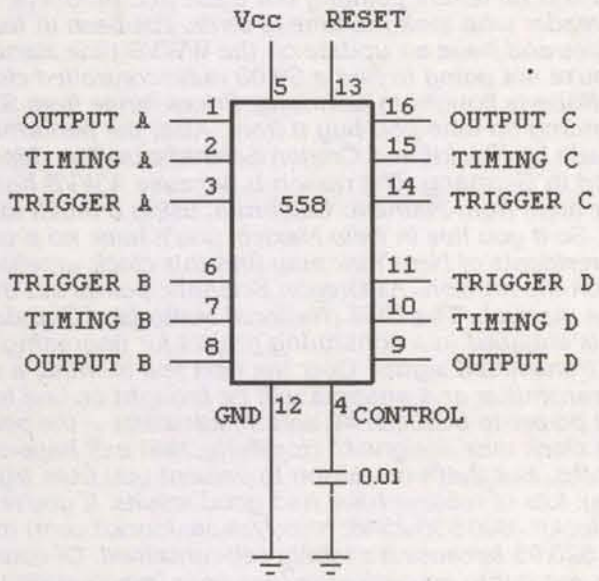
The ATTRIB command first removes the read-only and hidden attributes, then replaces them after the file is copied. What are hidden files? They're "setup" files that are hidden from public view so that you're not tempted to erase or modify them.

What's An LM558?

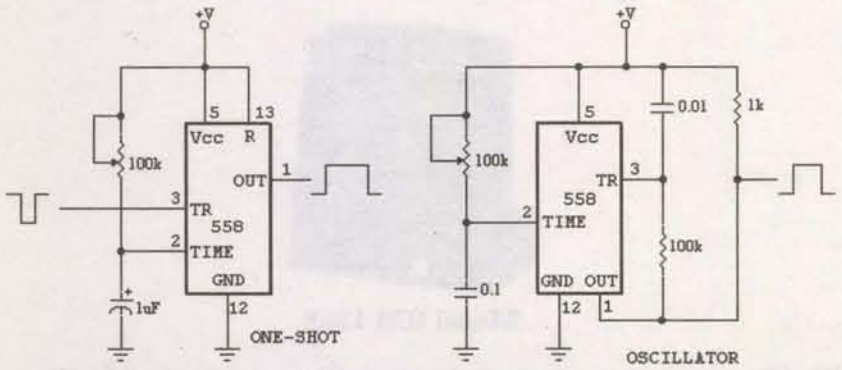
Q. I can't find a pinout for a 558 timer IC. Can you help?

Phil Clock
Proctor, MN

A. That's probably because this chip is long obsolete. However, if you have a shoebox full of them, that's no consolation. Here's the pinout.



Basically, the 558 is four independent monostable timers in one package. Each timer is similar to a part of a 555 timer. The reason the 558 didn't make it is because of the limited number of inputs which, in turn, limits the things you could with the individual timers. The chip operates from 4.5 volts to 18 volts, and the Reset and Control Voltage pins are common to all four timers. Want to know how to use it? Here's how.



Note that the lack of a discharge pin (the discharge and threshold are connected internally and called Timer) prevents the timer from operating in the pulse generator mode. My preference is the 556 CMOS timer (Radio Shack 276-1728), which contains two complete 555 timers, can be battery operated, and has a smaller footprint (14 pin vs. 16 pin) than the 558.

VESA Feature Connector

Q. As you may know, most PC video cards sport a VESA feature connector. I'm looking for detailed technical info on interfacing to this connector. I've found several pinout listings, but I need to know about the signal timing and duty cycle. What I want to do is build my own dot clock and sync

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timing circuit to run the video card at a fixed frequency, assuming that the necessary inputs are available on the connector.

David Tiefenbrunn N1WWY
via Internet

A. *Well, you don't have to go to the features connector to do this. It can be done in software by addressing the BIOS registers on the video card (dot clock not included). Visit these Web sites for information about VESA register programming: http://www.scitechsoft.com, http://www.delorie.com, and http://www.gameprogrammer.com/1-vbe.html. A good book on the subject is "Programmer's Guide to the EGA and VGA Cards," Richard F. Ferraro, Second Edition 1990, Addison-Wesley, ISBN 0-201-57025-4, which is available from Amazon Books (http://www.amazon.com). If programming won't solve your needs, you can order the VESA specs from VESA at http://www.vesa.org/ve00013.html. The document includes sync and timing specifications for the features connector, as well as information on the BIOS registers.*

Reader's Tip

On a question you had dealing with malfunctioning parallel ports (Jul. '98), you suggested software problems. Another possibility is that the reader is using a switchbox or plugging a printer onto the ports with the power on, and has suffered ESD damage to three of his four machines. In short, his parallel ports could be failing because he is killing them, not because they're dying! A quick way to rule out fancy software is to go into DOS and type

DIR > PRN

This should print the contents of the directory to the printer via the parallel port, if it's working, because there's not much between DOS and a parallel port!

Michael Mahon
via Internet

MAILBAG

Dear TJ Byers:

With reference to your Jul. '98 article regarding a WWVB clock, there is a clock available at a reasonable price. I bought an Oregon Scientific "Time Machine" a few weeks ago on sale at Fry's for just $25.00. They currently sell for $30.00. It seems to work great.

Ralph Goff
via Internet

In regards to Steve Roberts question and your answer, check with Klockit, P.O. Box 636, Lake Geneva, WI 53147. The stock number is #10087 and it sells for $28.95. It not only does time correction, but also adjusts for daylight savings time. This is a fine outfit that has been in business for many years.

M. F. Hewitt
Duarte, CA

Response:

I received several letters pointing out these two products, and I thank every reader who took the time to write. I've been in touch with both companies and have an update on the WWVB time standard. For one thing, you're not going to find a $9.00 radio-controlled clock like the kind Mr. Roberts bought in Germany. Prices range from $30.00 to $99.00, depending on who you buy it from. Also, the performance of the clocks made by Klockit and Oregon Scientific isn't as dependable as those found in Germany. The reason is because WWVB has to cover a wider area, from Maine to California, using a much weaker 26KW signal. So if you live in New Mexico, you'll have no problem at all, whereas residents of New York may find this clock unreliable. But there's hope on the horizon. As Oregon Scientific points out in their Time Machine manual, "The NIST (National Institute of Standards and Technology) is engaged in a continuing project for upgrading the power of the transmitted signal. Over the next few months, a second high power transmitter and antenna will be brought on-line to double WWVB's total power to between 40 and 50 kilowatts – the power level for which the clock was designed." Hopefully, that will happen in the next few months. But that's no reason to prevent you from trying it for yourself today; lots of readers have had good results. If you're handy, I suggest a Klockit (800-556-2548; http://www.klockit.com) movement for just $28.95 because it's totally self-contained. Of course, you'll have to put it into an enclosure (use your imagination!). If you'd rather plug and play, buy an Oregon Scientific (503-639-8883; http://www.oregonscientific.com) digital clock from Fry Electronics (http://www.megatech-software.com/fryloc.htm), Radio Shack (63-970), or another of their retailers.

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The downside is that it uses an external antenna that you attach to a wall or (preferably) a window. Maybe, as the WWVB transmitter power increases and receiver prices drop, the US may someday have a $10.00 radio-controlled alarm clock, too.

TJ Byers
Q & A Editor

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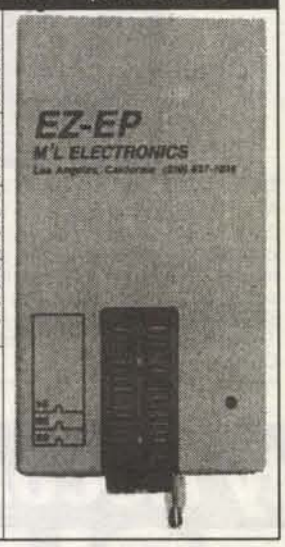

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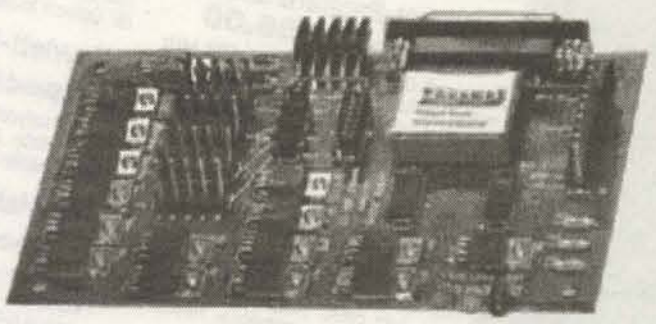

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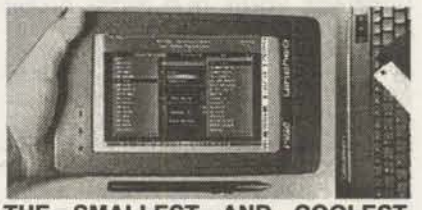

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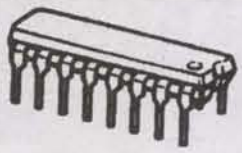

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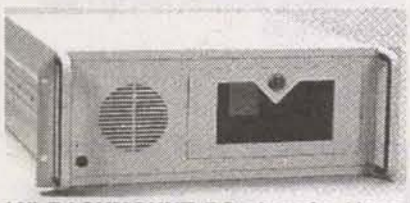

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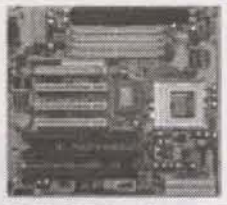

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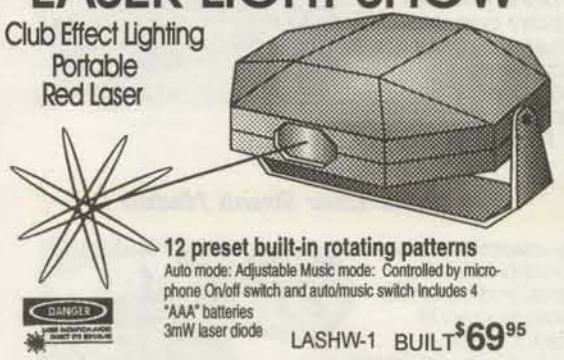

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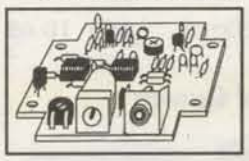

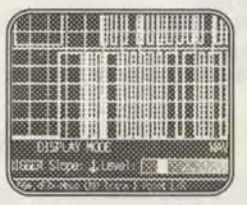

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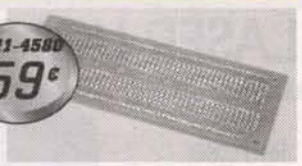

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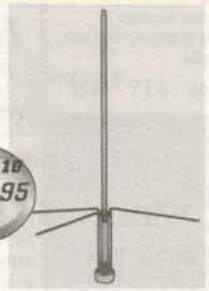

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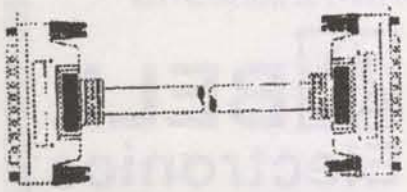

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Tyan Turbo-2 AT/ATX, Intel 430TX w/6 SIMM/2 DIMM 512K	$89
SuperMicro P55MMS98-Intel 430TX, 512K	$129
ASUS TX97/TX97E, AT-430TX,P75-233 PCI w/512K	$119
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BCM QS440BX - Intel 440BX Chipset, PCI/ISA/AGP/DIMMs, ATX	**$179**
Intel AL440LX - Intel 440LX, PCI/ISA/AGP/DIMMs,Audio,ATX	$ 149
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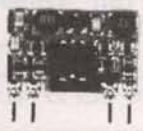

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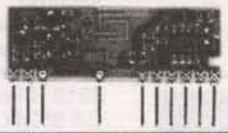

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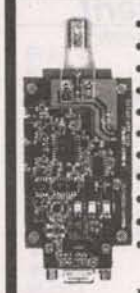

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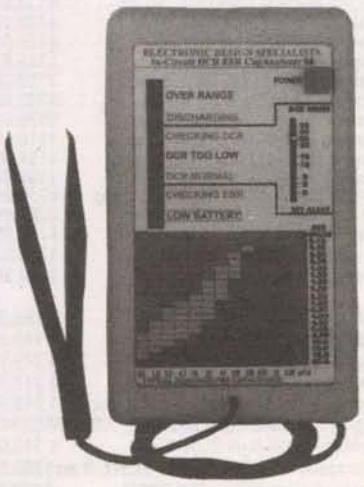

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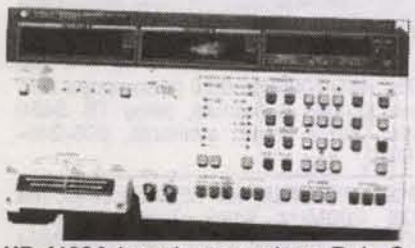

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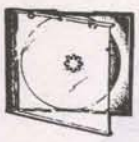

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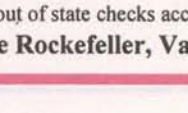

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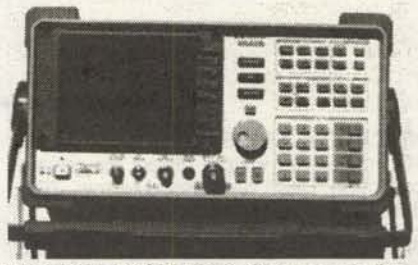

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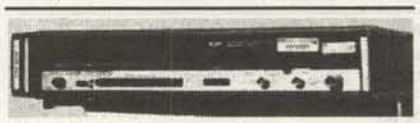

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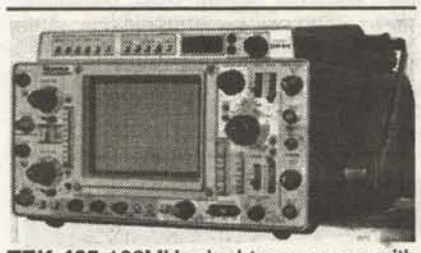

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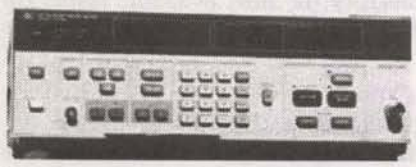

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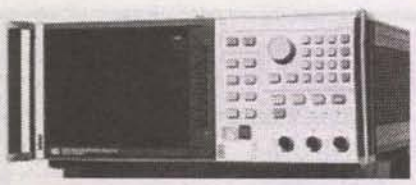

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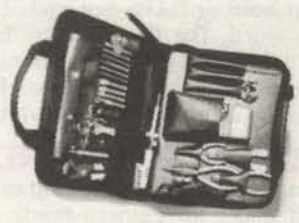

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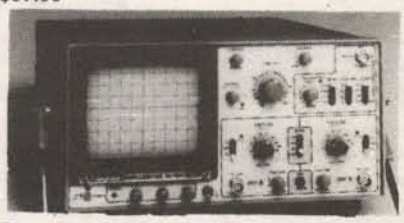

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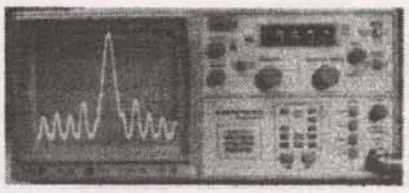

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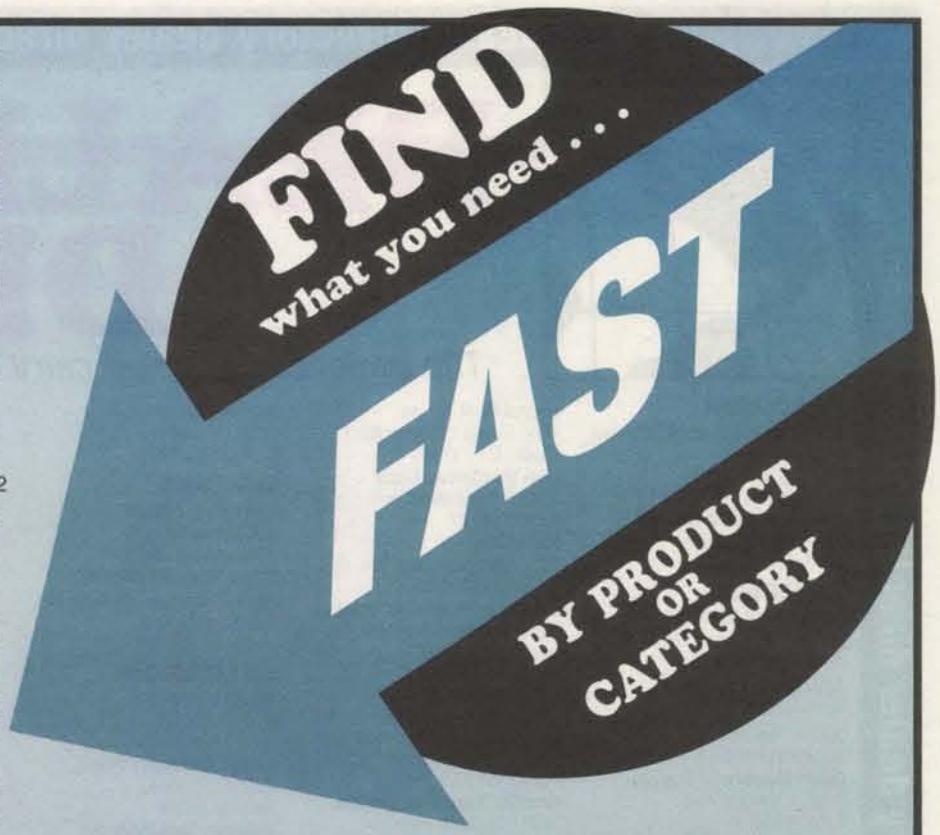

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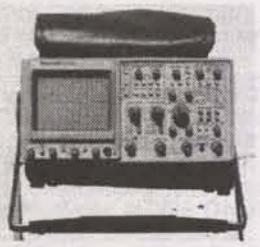

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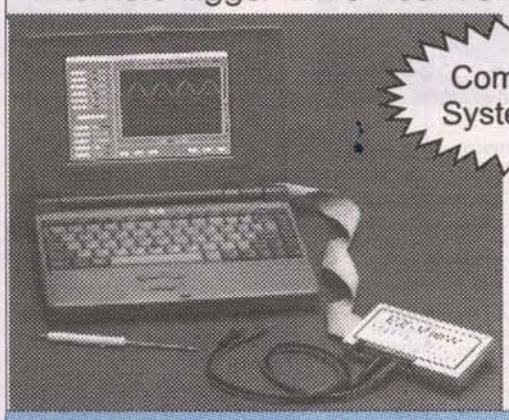

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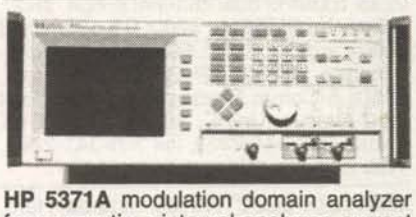

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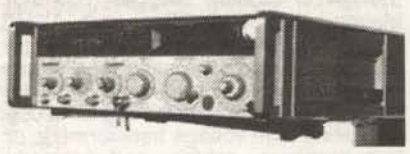

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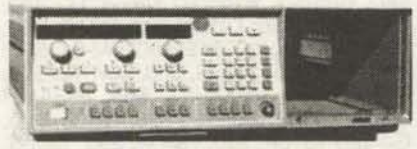

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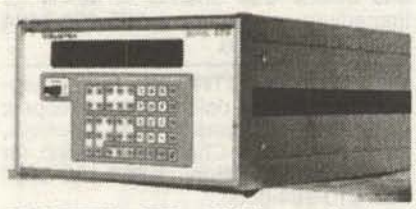

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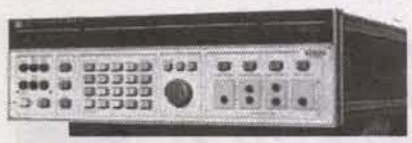

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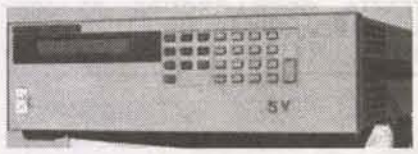

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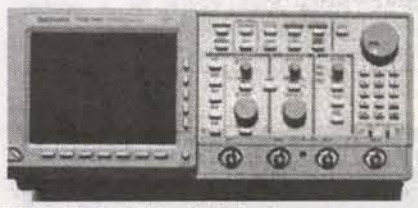

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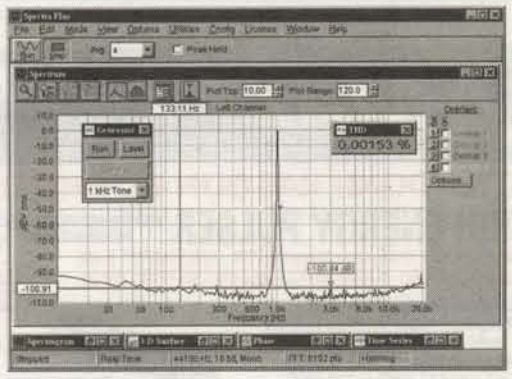

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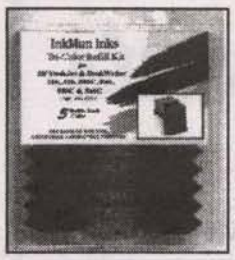

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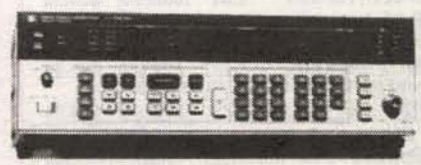

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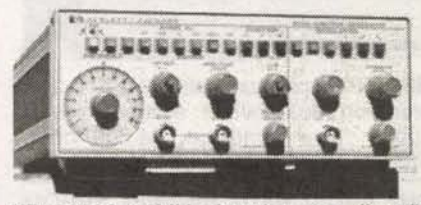

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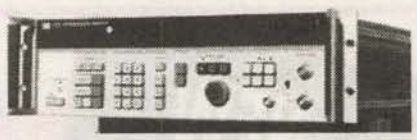

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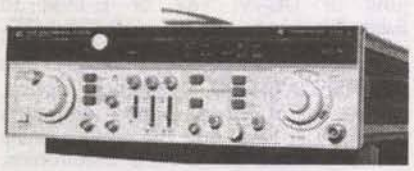

HP 8684B 5.4-12.5GHz signal generator. Pulse, AM-FM +10 to -130 dBm state-of-the-art. Cataloged at $21,000, $4,500 offer. NIST certs. available. 805-245-1810.

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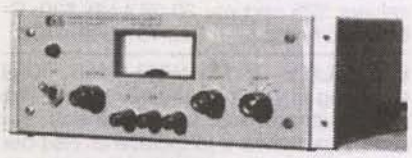

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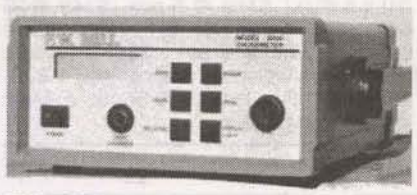

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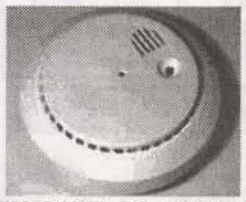

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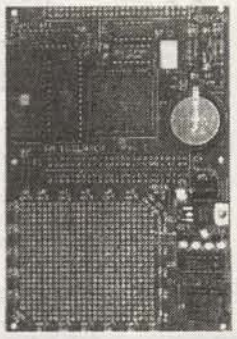

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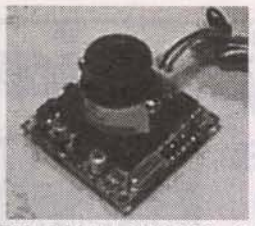

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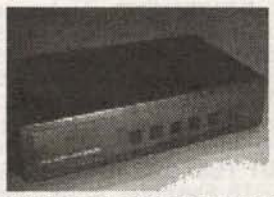

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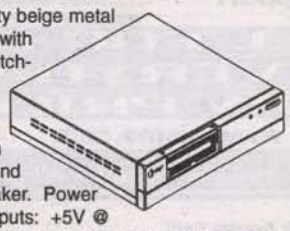

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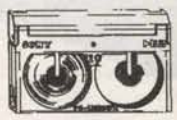

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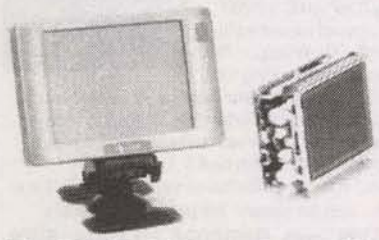

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8107 $399.95, 30V/10A.
8110 $289.95, 60V/3A.
8112 $399.95, 60V/5A.
Digital Voltmeter & Analog Ammeter
8200(8201) $179.95($239.95), 30V/3A(5A)
Digital Displays **8210/8300 $199.95**, 30V/3A.
8211/8301 $259.95, 30V/5A.

DUAL OUTPUTS
Independent/Tracking
Analog Displays
8108 $549.95, 60V/3A.
8109 $699.95, 60V/5A.

PS-303D $314.95, 30V/3A. **PS-305D $399.95**, 30V/5A.

TRIPLE OUTPUTS, **a fixed 5V/3A output, Indep./Tracking**
Digital Displays **8202(8203) $499.95($549.95)**, 30V/3A(5A)x2.
Analog Displays **8102(8103) $399.95($489.95)**, 30V/3A(5A) x2, with *Parallel* (30V/6A) and *Series* (60V/3A) Mode operation.

NTSC/PAL TV COLOR BAR GEN.

CPG-1366A $159.95, VHF NTSC;
Freq.: 45.75, 175.25, 187.25 MHz;
RF Output: 10mV; *Impedance*: 75Ω;
Video Output: BNC, $1V_{p-p}$;
Power: 9VDC; 9V AC adapter (**$6**).

CPG-1367A $159.95, VHF PAL.

SWR/RF/mW POWER METER

310 $89.95, 1.8-150MHz; *RF Power*: 0-4W/20W/200W 3 ranges; *SWR Measurement.*:1.0~∞, 4W min. Accuracy: 5~10%; *Insert Loss*: .3dB *In/Output Imp.*: 50Ω; SO-239 plug.
320 $89.95, 130-520MHz. Spec. 310.
330 $119.95, 1.8-520MHz. Spec. see 310.

SWR-3P $26.95 1.7-150MHz;
RF Power: 0.5-10W, 0.5W-100W.
SWR-2P $22.95, 1.7-30MHz; *RF Power*: 0.5-10W.
mW RF Power Meter 340 $219.00, 1.8-500MHz; *RF Power*: 20mW/200mW/2W 3 ranges; *Imped.*: 50Ω; *Accuracy*: ±10% full scale; SWR <1.15; N-type connectr; BNC type output

FM STEREO MODULATOR

AG-2011A $549.00
RF SECTION:
Carrier: 98MHz±2MHz;
Output: 10mV, 1mV & 0.1mV
COMPOSITE SIGNALS:
Pilot: 19KHz±2Hz, 0.8Vrms
INT. MODULATION: 400KHz, 1KHz±1%, 1Vrms, distortion < .5%;*L-R Separation*: >50dB.
EXT. MODULATION: *Freq.*: 50Hz-15KHz
L-R Separation: >45dB 100Hz-3KHz; >35dB 50Hz-15KHz.

WOW-FLUTTER METER

WF-3103A $699.95 *Freq. Range*: 3KHz±10% JIS/CCIR; 3.15KHz±10% DIN. *Measure*: .03/.1/.3/1/3% full scale. *Accuracy*: ±5% of full scall.

WF-3105A $799.95 digital display *Function*:LIN/WOW/Flutter/WTD. *Freq Counter*: 10Hz-9.99MHz. *Indication*: CCIR/DIN/JIS.

TOOLKITS - ELECTRONIC/PC

9Z45 $29.99 U.S. Patented, 45-pcs. Contents: IC insert/extractor with securers & bows, 3-prong part retriever, #0 phillips screwdriver, 1/8" flat srewdriver, self-hold tweezers, metal tweezers, part tube, soldering iron, solder, crimping tool, long-nose plier, cuttng plier, zipper vinyl case. Bits include: *Phillips*: #0/#1/#2/#3; *Flat*: 1/8"/3/16"/1/4"/9/32"; PZ1/PZ2; T8/T9/T10/T15/T20/T25/T27/T30/T40/T45; *Hex*: 5/64"/3/32"/1/8"/5/32"/3/16"; *Sockets*: 3/16" (5mm)/7/32" (5.5mm)/1/4" (6mm)/9/32" (7mm)/5/16" (8mm).
8G23 $34.99 23-pcs *Contents*: IC inserter/extractor with securer & bows, 3-prong part retriever, 3/16"/1/4" nutdriver, 3/16"/ 1/8" sloted screwdriver, #0/#1 phillips, reversible T10/T15 bits, reversible #2 phillips/¼" slotted bits, tweezer, long-nose plier, cutter, 6" adj. wrench, soldering iron, solder, crimping tool, zipper case.
Various packages available, call/write/e-mail/fax for detail.

RF SIGNAL GENERATOR

SG-4160B $124.95, 100K-150MHz up to 450MHz on 3rd harmonics in 6 ranges; AM modulation; *Accy*: ±5% *RF Output*: 100mVrms to 35 MHz; *Modulation*: Int. 1KHz (AM); Ext. 50Hz-20KHz, at least $1V_{rms}$ input. *Audio Output*: 1KHz, $2V_{rms}$ min.
SG-4162AD (w/ Freq. Counter) $229.95, Spec. see SG-4160B.
COUNTER SECTION: 10Hz-150MHz; *Max. Input*: ≤3Veff; *Gate Time*: .1, 1sec. *Input Sensitivity: 35mV, 10Hz-200MHz. Input Impedance*: 1MΩ(HF), 50Ω(VHF). *Display*: 7-digit LEDs.

AM/FM STD SIGNAL GEN.

SG-4110A $1799.00, *Freq*: 0.1~110MHz; *Display*: 6-digit LED; Resolution: 100Hz (0.1~34.999MHz); 1KHz (35MHz~110MHz). *Accuracy*: <±($5x10^5$ ±1 count); *Output*: -19dBu~99dBu, 1dB steps. *Imped.*: 50Ω VSWR 1.2; 100 preset frequency, store funct.

AUDIO GENERATOR

AG-2601A $124.95, 10Hz~1MHz in 5 ranges; *Output*: sinewave 0~$8V_{rms}$; square $10V_{p-p}$. *Output Imped*: 600 Ω *Distortion*: <0.05% 500Hz~50KHz; <0.5% 50KHz~500KHz.
AG-2603AD $229.95, with 6-digit, Int/Ext. Freq Cntr, 10Hz~150MHz, *Output Control*: 0/-20/-40dB & fine adjuster, spec. see AG-2601

FUNCTION GENERATOR

FG-2100A $169.95, 0.2Hz-2MHz in 7 ranges; sne, square, triangle, pulse & Ramp; *Output*: $5mV_{p-p}$-$20V_{p-p}$, 1% distortion. *VCF*: 0-10V/freq. to 1K:1
FG-2102AD $229.95 see FG-2100a; 4-digit counter display; CMOS & TTL Output, 30ppm ±1 cnt accuracy
FG-2020B $159.00 0.5Hz-500KHz; Sine, Square, Triangle.
FG-2103 $329.95, Digital sweep generator, 0.5Hz-5MHz in 7 ranges. *Operating Mode*: sweep, AM, gated burst, VCG. *Freq. Counter*: Int. 0.5Hz-5MHz; Ext. 5HZ-10MHz.
FG-513 $769.95, 13 MHz, Microprocessor embedded sweep; *Freq. Counter & TCXO*: 5Hz-100MHz, 6.5 digits. x1/x20 attenuation; Sine/Square/Triangle/Pulse/Ramp/TTL & DC; ±(.01%+1).

AC MILLIVOLT METER

MV-3100A $159.95 wide band 5Hz~1MHz; 3 scales, mV/dB/dBm; 300μv ~100V in 12 ranges, 10μv resolution; -70~40dB in 12 ranges, 0dB=1Vrms, 0dBm=0.755V; ±3% accuracy; Input impedance 10MΩ; Noise <2%.
MV-3201B $309.95 2 ch.; simultaneous measurement; spec see MV-3100

OSCILLOSCOPES

OS-7305B $249.00 DC~7MHz; 3" CRT; *Horz*: .25V/div; 10Hz~100K Hz in 4 ranges; *Vert*: 10mV/div; Int./Ext. sync.; *Input*: 1MΩ/35pF.
OS-7010A $299.95 10MHz, 5" crt; *Horz*: .2V/div; *Vert*:10mv~10v /div
OS-622G $389.95 20MHz, 2 CH.; Alt trig., trig. lock, hold off, TVsyn. 8x10 div., 1mV/div., *Horz*: .2μs~.5s/div; *Vert*: 1mV~5V/div.
OS-653G $699.95 50MHz, 2 CH/delay sweep, Alt trig., TV syn.
OS-6101G $1499.95 100MHz, 4ch/8 traces, delay sweep, cursor readout. *2 years warranty for OS-620, 622G, 653G, 6101 &6102*

UHF ATTENUATORS

RT-8815U (50Ω) $299.00 / RT-8817U (75Ω) $299.00, 950MHz 81dB, 0.5W max.; *Steps*: 1/2/3/5/10/20/20/20, 8 switches.
085E-2 (50Ω) $399.00 / 087E-2 (75Ω) $399.00, 950MHz, 81dB, 0.5W max.; *Steps*: 10dB+7.1dBx10, Electronic adjustment knob.

MICROPROCESSOR TRAINER

BGC-8088 $699.00, learn computer theory. Excellent for school & individual who want to learn about ROM, RAM, I/O ports, programming, & run a 8088 Microprocessor. An easy to understand step-by-step manual guides you to achieve your goal. 56-key keyboard, LCD display, RS-232, UART...

GRID DIP METER

DM-4061 $89.95 1.5-250MHz, 6 bands; 6 plug-in coils, 2 transistor, and 1 diode. *Modulation*: ≈ 2KHz Sinewave. *Crystal Oscillator*: 1-15MHz. Wave absorption meter. 9VDC battery.

FREQUENCY COUNTER

FC-5250C $119.95 10Hz-220MHz HF:10Hz-20MHz;VHF:10-200MHz *GateTime*: .1, 1s; *Max. Input*: $10V_{p-p}$ *Sensitivity*: 35mV/10Hz-200MHz; *Input Imped.*: HF:1MΩ; VHF:50Ω; *Display*: 7-digit; 9V adapter (**$6**).

FC-5260A $129.95 10Hz-600MHz, 7-digit LEDs. 9V AC adapter (**$6**).
FC-5270 $149.95 10Hz-1.2GHz, 8-digit LEDs. 9V AC adapter (**$6**).
FC-5600B $229.95 10Hz-600MHz, 10-digit LEDs; 110/220VAC.
FC-5700 $299.95 10Hz~1.3GHz; 10-digit LEDs; Period measure

SIGNAL TRACER/INJECTOR

SE-6100 $134.95
TRACER: Gain 60dB maximum. *Attenuation*: 0/20/40/60dB
Input Imped: 100kΩ; *Meter*: Vu .1mA
Output Imped.: 600Ω; *Speaker*: 8 Ω.
INJECTOR: ≈1KHz Squarewave; *Output Level*: Variable 0 ~ $4.5V_{p-p}$; 9V battery or adaptor (**$6.00**).

LCR METERS

MIC-4070D $179.95, *L*: 0.1μ~200H, *C*: 0.1p~20mF, *R*: 1mΩ~20MΩ, 2Ω range, Dissipation factor measurement, Zero adjust; Surface mount device (SMD) test probe: **LT-06 $21.95**

DIGITAL MULTIMETER

DMM-120 $24.95, 3½ dig.; 600vDC, 2ADC 500vAC, 2MΩ, hFE/diode/continuity; 1.2%.
DMM-123+Cap. $44.95, 3½ digit; 600vDC, 600vAC, 10ADC/AC, 2GΩ, 20μF, hFE & diode test, continuity beeper; 0.8% accuracy.
DMM-124+Cap.+Temp.+Freq $69.95, 3½, 600vDC/500vAC, -58~752° F, 2GΩ, 20mF, 200KHz, 3-phase/diode/continuity test; 1.2%
DMM-125 $54.95, Auto./Bargraph, 32MΩ, 600vDC/AC, 10ADC/AC, diode/continuity.
MIC-35 $59.95, 3½ LCD, Autorange 20MΩ 1000vDC/750vAC, 20ADC/AC, data hold, diode/continuity test, free holster; 0.5% accy.
MIC-39 $129.95, Auto/Bargraph, True RMS, 3½ LCD, 40MΩ, 40μF, 1000vDC/750vAC, 20ADC/AC, 600KHz freq. cntr, data hold, sleep mode, memory, read functions, holster; 0.3% accuracy.

POCKET ANALOG MULTIMETER AMM-9810P $14.95

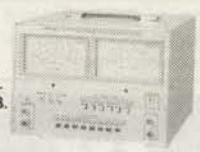
DCV: *Range*: 10/50/250/500V; ±4%.
ACV: *Range*: 50/250/500V; ±4%.
DCA: *Range*: 25mA, 250mA; *Accuracy*: ±4% full scale; *Protection*: 0.5A/250V fuse.
Resistance: *Range*: **500kΩ (x 1k)**; ±5%.
dB Test: +4 to +56 dB on ACV range; *Accuracy*: ±5% of full scale.
Battery Test: 1.5V and 9V.
Max. Input: 500VDC/AC, or 250mADC.

AUTO. CAPACITANCE METER

CM3300A $139.00 10 ranges, 99.9pF ~ 99.9mF, fully automatic. *Resolution*: 0.1pF lowest, 0.1% full scale. *Accuracy*: 0.5% of full scale ±1 digit to 99.9μF, 1% of full scale ±1 digit to 99.9μF. *Display*: 3 digit LED. *Unit*: pF, nF, μF, mF, Overflow indicator.

AUTO DISTORTION METER

DM-3104A $799.95
DISTORTION MEASURE
Range: 0.01% to 30%, 0.1/0.3/1/3/10/30% 6 ranges.
Freq: 400Hz±10%, 1kHz±10%(HPF).
Input: 3mV~100V; Ratio meas. 20dB.
Auto. Freq. Switching Ranges: Fundamental Freq. = (fo)±10%;
Fund. Rejection: >-80dB at (fo)±5%; >-70dB at (fo)±10%.
Harmonic Accuracy: ±0.5dB, 1.8(fo)-20KHz.
LEVEL MEASURE *Range*: 0~100V; .03/.1/.3/1/3/10/30/100V;
Freq Response: ±0.5dB/20~50kHz; ±1dB/20~100kHz.
DM-3204 $1,599.00 dual channels; Spec see DM-3104A.



PRICE BUSTER, DSP, COLOR CAMERA,

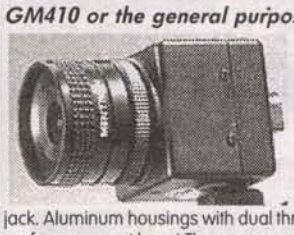
Brand New, model GM550, Size: 1.6" x 1.6" x1.5"L, 1/3" CCD with SONY CCD & DSP technology. 4mm, f1.8 glass lens, 80° FOV. Resolution >350 lines, sensitivity, 0.3lux, AWB, AGC & auto electronic shutter 1/60 to 1/10,000 sec. Pwr. 12VDC @160ma. NTSC out. Budget color surveillance.

Reg. $269, SPECIAL GM550....$149ea.

WORLDS SMALLEST COLOR, DSP, MICRO CAMERA

New. For size sensitive color applications now you have a choice. Not a CMOS camera! 1/3" CCD, 400 Lines resolution, 0.3 Lux sensitivity, Auto white balance, AGC, Auto Shutter, 12VDC @160mA, 4.3mm, 80° FOV lens, A real glass lens. NTSC video out. Size: 30mm sq X 36mm deep. Pinhole only 21mm deep! The smallest, highest performance color camera available today. **GM500-STD or PINHOLE.....$249ea.**

TWO MINI C-MOUNT CAMERAS, The super sensitive, GM410 or the general purpose GM412,



The GM-412 specs: B&W, size 1.5"sq. X 2.4"L, 250,000 Pixels, **380** Lines Resolution, Sensitivity **0.3** Lux, The GM410 specs: size only 1.5" SQ. x 1.6"L, >270,000 Pixels, **410** Lines Res., Sens. **0.05 LUX.**, Both cameras are 1/3" CCD with AGC & Electronic shutter. 12V @110mA power. NTSC out. IR SENSITIVE, BNC video out, Both use std. DC pwr. jack. Aluminum housings with dual threaded top and bottom mounting. True performance not hype! These cameras will outperform ***ANY*** camera in this magazine. Multi- lens options are available to exploit their superior performance. **GM412, less lens..$119, GM410, less lens..$169**

C-MOUNT LENS OPTIONS to ENHANCE YOUR IMAGE:

Fast Lenses for Low Light or General Purpose Normal Light

16mm, f1.6, 15° FOV $39	**4mm, 80° FOV $24**
8mm, f1.3, 30° FOV $49	**8mm, 40° FOV $24**
4mm, f1.4, 56° FOV $49	**12mm, 28° FOV $24**

PRICE BUSTER, DSP, COLOR, MINI C-MOUNT, CAMERA,

Brand New, model GM859, Size only: 2" x 2" x2.5"L, Latest 1/4" CCD technology. Res. 350 lines, sens., <3lux, auto white balance, AGC. Auto iris connector. 9-12VDC @150ma power. BNC video out. Switchable gain. Superior cast aluminum housing with top and bottom mounting. Perfect for general surveillance. Less lens. Lens options listed below. **Reg. $299 Save over $100, Special, GM859...$189**

MOTORIZED ZOOM LENSES, Up to 10X mag. and auto iris !

New, fabulous hi-res. optics with std. C-Mount. Superior Fujinon and Vicon lenses. Normally cost from $600 to $1500. There is no substitute for a good lens! All drive motors will operate from 6-12VDC. The Auto iris models have a built in amp which uses the camera video output for control. They will work with any camera whether or not it has an "auto Iris" connector.

Type A-10, 11 to 110mm, 10X, f1.8	$399
Type B-6, 12.5 to 75mm, 6X, f1.2	$229
ZOOM LENS CONTROLLER, NEW	$169

Exclusive "LAB STYLE" LASERS, 650nm or 635nm, Rugged and dependable. Year warranty.

Adjustable X & Y beam position. Aircraft aluminum housing. Internal battery and on-off switch included. Also a super pointer. .75d x 2.75"L

650nm $69,

635nm $99

MOTORIZED PAN and MOTORIZED TILT,

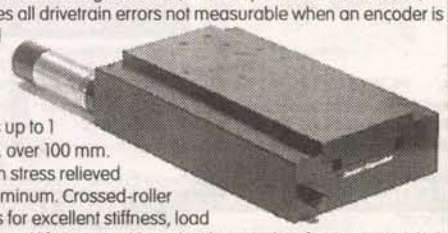
Now you can remotely PAN and TILT your video cams. Vicon model 3030 indoor units are NEW and operate on 24VAC provided. The complete system includes Pan & Tilt controller with internal power supply Easy hookup info included. Max load 7.5Lbs. Size: 5.25"W x 5.25"L x 5.25"H Approx. -10 ,to +50 deg. of tilt. Commercial quality unit. ***VICON 3030.....$249***

END FIELD of VIEW GUESSWORK! 3.5 to 8mm VARIABLE FOCAL LENGTH LENS.

Brand New, super f1.8 lens allows you to smoothly adjust from a 97° FOV @ 3.5mm to a 44° FOV @ 8mm. Now you can frame your area of interest just the way you want it! Or use it as a tool to select a fixed lens of the proper field of view. Either way a handy item to have. Standard C-Mount with adjustable focus and iris.

SPECIAL.... $99ea. or 2 for $189

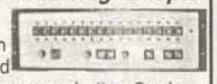
PRECISE, KENSINGTON LABS, LINEAR STAGE.



Model 8500-10, 10" high performance travel. One of the best linear stages available. Highly repeatable, ultra-precise. Precision ground surfaces result in unmatched laboratory-grade performance. Linear glass scale, internally attached to the table, eliminates all drivetrain errors not measurable when an encoder is attached to the motor. System provides up to 1 µm accy. over 100 mm. Built from stress relieved 7075 aluminum. Crossed-roller bearings for excellent stiffness, load capacity and lifetime. Combined with a very low friction preloaded leadscrew and DC servo motor drive provides 20,000 hour MTBF. 100 mm/sec maximum speed and 68 kg load capacity. Size:15"L x 9"W x 2.75"H Regular price > $5Kea. NEW!

8500-10 LINEAR STAGE .....$1595ea.

16 CHANNEL DIGITAL VIDEO MULTIPLEXER, allows real time, multi-camera recording to tape.



NEW! American Dynamics, 1484SL-16. Allows recording of up to 16 cameras on one video tape. Video loss detection and pre-loss frame memory. Manual/auto camera selection. Can be rack mounted. A quality unit. Very limited quantity available.

AD1484SL-16..... $799ea.

SUPER! UNDERWATER (60 ft.) "LIPSTICK" CAMERA with INTEGRAL INFRA-RED ILLUMINATOR!

Sleek black anodized, BRASS, housing is O-Ring sealed & WATERPROOF. Adjustabe mount included. Specs: 1/3" CCD, 400 Lines resolution, 0.05 Lux sensitivity, AGC, Auto Shutter. Operates on 12VDC @225mA, 3.6mm, 92° FOV lens, A real glass lens. NTSC video out. Superior construction. SENSITIVE to IR. Ultra small Size only: 1.25"diam. X 2" long. With 60 ft. cable. Great for general outdoor use also.

REG. $299 SPECIAL, **GM-300KIR.....$199**

SEE in TOTAL DARKNESS! WEATHERPROOF IR FLOOD,

48 powerful LED's project a 40 deg. FOV beam up to 45 feet. Automatic on at dusk off at dawn! 110VAC power. Rugged anodized aluminum, housing with adjustable mtg. bracket Size: 4"x5"x6.3"L Commercially made. Brand New! **WPIR....$179ea.**

CHECK THIS! ULTRA MINI and WEATHERPROOF

Our "LIPSTICK" camera sets new standards. Sleek black anodized, aluminum, housing is O-Ring sealed & RAINPROOF. Adjustable tilting mount included. Specs: 1/3" CCD, 380 Lines resolution, 0.3 Lux sensitivity, AGC, Auto Shutter. Operates on 9 to 12VDC @100mA, 3.7mm, 90° FOV lens, A real glass lens. NTSC video out. 1/2 once! SENSITIVE to IR. Ultra small Size only: 23mm diam. X 50mm long. With 36" leads.

GM-200KSTD...$119 pwr. adapter..$4.95

"EMBEDABLE", PINHOLE LENS, "BULLET CAM" it's INCREDIBLE !

So tiny you can install it right into a door with merely an 0.9" diameter hole. Sleek black anodized, extruded aluminum housing. Similar construction as the lipstick camera above only smaller! 1/3" CCD, 410 Lines Res., 0.3 Lux sens., AGC, Auto Shutter. Power from 9 to 16VDC @100mA, 250k PIXELS, 90° FOV Pinhole lens. A real glass lens. Std. NTSC video out. 1/2 once! SENSITIVE to IR. Size only 23mm Diam. x 35mm long. With 36" leads. Think of the places you could put this little jewel. **GM-200KPH lens,...$129**

NEW MICRO CAMERA, w/audio 1/3" CCD,

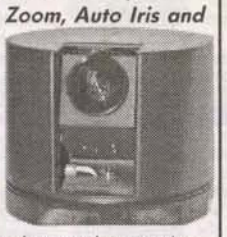
410 Lines Res., 0.3 Lux sens., AGC, Auto Shutter. Pwr. from 9 to 12VDC @100mA, 250k PIXELS, Std. model, 3.6mm, 92° FOV lens, Pinhole, 90° FOV. A real glass lens. Both focus from 10mm to infinity. Std. NTSC video out. 1/2 once! SENSITIVE to IR. Size Std: 1.25"sq. x 1"d. PH is 0.6"d, Both with 6" leads. **WARNING:** Don't confuse these models with LOW RESOLUTION, HIGH LUX C-MOS CAMERAS.

GM-1000A-STD.....$80	**GM-1000A-STD/Audio.....$85**
GM-1000A-PINHOLE.....$80	**GM-1000A-PH/Audio.....$85**
GM-1000A-C-MOUNT...$80	**GM-1000A-CMNT/Audio.$85**

C-Mount f2.0 Lenses	Micro Lenses for GM1000 series
4mm, 80°.....$24	2.5mm, 150°.....$22
8mm, 40°.....$24	4.3mm, 78° f1.8.....$22
12mm, 28°.....$24	5mm, 70°PH.....$22

Please fax us your list of unique surplus material.

SONY, COLOR CONFERENCE CAMERA, 450Line, 8X, NTSC & Y/C OUT,



Serial Control of Pan, Tilt, Zoom, Auto Iris and Auto Focus too! Like having your own R2D2. Intended for use in fortune 500 board rooms. The video performance is stunning. Superior to almost anything we have seen. Camera and lens is an integral assembly. Excellent Condition. Rugged black ABS enclosure. 8 pin mini-DIN & Std. SVHS jack. Size: 8"Dx6.5"H. Sorry, we have no data on using the serial port. The units self test on power up and the video is active. Reg price over $4K **SPECIAL PRICE....$289ea.**

Brand New, Video Motion Sensor.

Model VM10. Attach to any standard video signal and you've got an electronic "watchman" diligently watching the entire scene. Or any adjustable sized area within the scene. Such as a doorway or even a drawer or cabinet. A state of the art security aid. The unit will close a contact when it senses a change. Use it to turn on a VCR or call the hounds. Auto or manual reset. Compact, ac powered. Adjustable sensitivity. Video loop through jack. **NEW VM-10.....$189.**

NEWPORT, MOTORIZED, ROTARY STAGE,

model 495A, Bidirectional 360° continuous rotation with 0.001° resolution. Integral DC motor and precision encoder. Load independent velocity servo. Can be mounted in any orientation. Load capacity: 55lbs. Size: 4.75"x5"x1.35" With 2" c lear aperture.

Newport price....$2141 Our Price...$795

10V @ 2.5 AH SEALED, LEAD ACID, PACK

Each pack consists of five, 2 Volt cells. Each cell the size of a std. 'D' battery. They are arrainged as 1X5 cells. Enclosed in an ABS outer shell. (removed for photo) Mint condition. Perfect for robotics and other high drain applications. Buy several, make custom packs of any rating. Size: 7.5"L x 2.8"H x 1.5"D

5-five packs for $20, 30 for $99

FREE ARGON LASER? 16mW Brilliant Tourquise Blue, SPECTRA PHYSICS, 161B with POWER SUPPLY

Our low price is like paying for the power supply and getting the laser FREE! The 488nm, TEMoo mode is nearly 10X brighter than a 16mW HeNe! This is the laser you always wanted but couldn't afford. Perfect for that kick butt light show! All are in good, plug and play condition. Standard 115VAC operation. Integral fan cooling. We priced the whole system for less than others charge for the power supply alone. Why spend more? Always in demand. Limited Qty.

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SECURITY ELECTRONICS SYSTEMS AND CIRCUITS — Part 8

by Ray Marston

Ray Marston describes circuits that react to temperature, voltage, current, or resistance in this month's episode of the series.

INTRODUCTION

Security circuits that react to temperature, voltage, current, or resistance have many practical applications in the home and in commerce and industry.

Temperature-sensitive circuits can be used to automatically activate alarms or safety devices when one or more monitored temperatures goes above or below a preset level, or when two temperatures differ by more than a preset amount.

Such circuits can be used to give warning of fire, frost, excessive boiler temperature, the failure of a heating system, or over-heating of a piece of machinery or a liquid, etc., and may use thermostats, thermistors, or various types of solid-state devices as their temperature-sensing elements.

The first half of this month's article presents a selection of practical temperature-sensitive security circuits.

Circuits that react to an input voltage, current, or resistance also have many practical applications, since these inputs may, in fact, be derived from the output of a transducer that monitors a parameter such as motor speed, liquid flow rate or pressure, or rate of linear movement, etc.

The second half of this article presents a selection of practical voltage-, current-, or resistance-sensitive security circuits.

Note that most practical circuits shown in this article are designed to activate a relay under the 'alarm' condition but that, in most cases, this relay can be replaced by a ready-built 12V piezo-siren module if required.

TEMPERATURE-SENSITIVE SECURITY CIRCUITS

THERMOSTAT FIRE-ALARM CIRCUITS

One of the simplest types of temperature-sensitive circuit is the thermostat-activated fire alarm. *Figure 1* shows the practical circuit of a relay-aided non-latching alarm of this type. Here, any desired number of n.o. thermostats are wired in parallel and then connected in series with the coil of a relay, and one set of the relay's n.o. contacts are wired in series with the alarm bell so that the bell operates if the relay turns on.

Normally, the thermostats are all open, so the relay and alarm bell are off. Under this condition, the circuit consumes zero standby current. At 'overheat' temperatures, on the other hand, one or more of the thermostats closes, and thus turns on the relay and thence the alarm bell. Note that push-button switch S1 is wired in parallel with the thermostats, enabling the circuit to be functionally tested by operating the push-button.

The basic *Figure 1* circuit gives a non-latching form of operation. If required, the circuit can be made self-latching by wiring a spare set of n.o. relay contacts in parallel with the thermostats, as shown in *Figure 2*. Note that n.c. push-button switch S2 is wired in series with these relay contacts, so that the circuit can be reset or unlatched by momentarily operating S2.

The thermostats used in the above two circuits must be n.o. types that close when the temperature exceeds a preset limit. When the thermostats are located in normal living areas, they should be set at a temperature of roughly 60°C (140°F), but when they are located in unusually warm places — such as furnace rooms or attics — they should be set at about 90°C (194°F).

OVER- and UNDER-TEMPERATURE SECURITY CIRCUITS

Most over-temperature (and under-temperature) security circuits activate a relay or an alarm unit when a monitored temperature rises above (or falls below) a preset level, which may range from well below the freezing point of water to well above the boiling point of water. Precision circuits of this type usually use one or more thermistors or solid-state devices as their temperature-sensing elements.

Two useful over-temperature security circuits (and two under-temperature circuits) are de-scribed in this section. The first two circuits use an inexpensive n.t.c. (negative temperature coefficient) thermistor as a temperature-sensing element.

This device acts as a temperature-sensitive resistor that presents a high resistance at low tem-

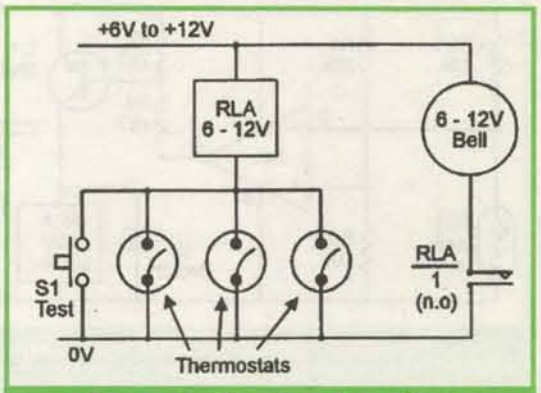

Figure 1. Simple relay-aided non-latching fire alarm.

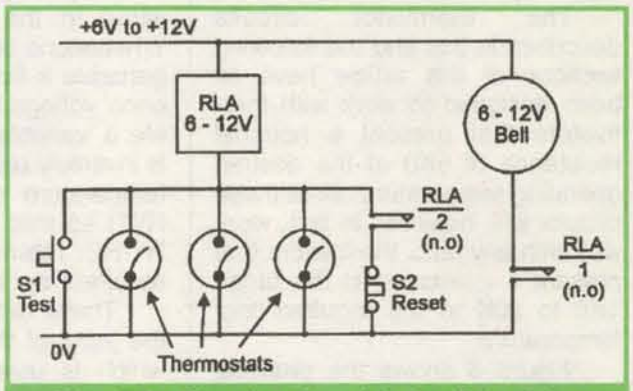

Figure 2. Simple relay-aided self-latching fire alarm.

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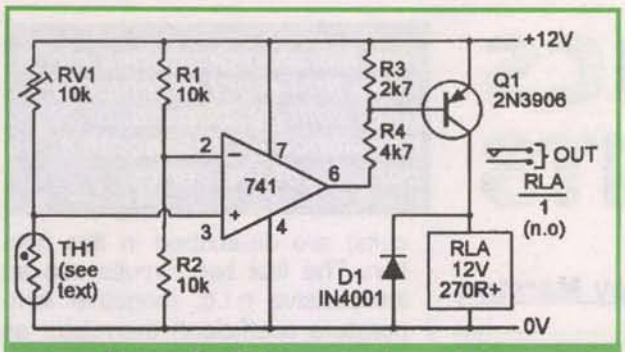

Figure 3. Relay-output precision over-temperature switch.

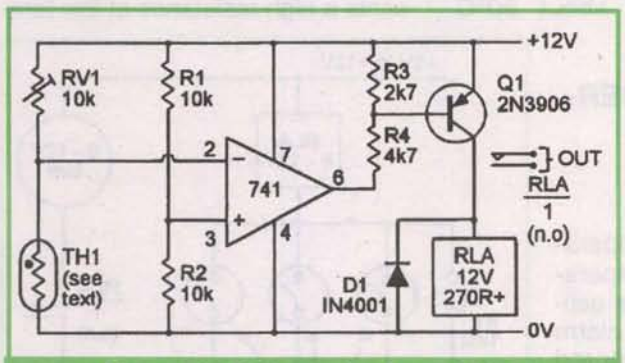

Figure 4. Relay-output precision under-temperature switch.

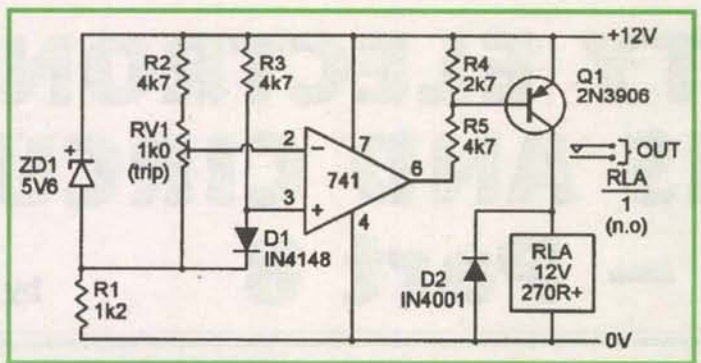

Figure 5. Relay-output over-temperature switch using silicon diode temperature-sensing element.

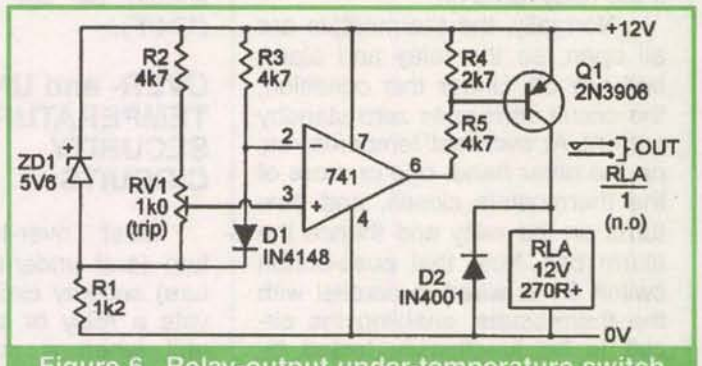

Figure 6. Relay-output under-temperature switch using silicon diode temperature-sensing element.

peratures and a low resistance at high temperatures.

The thermistor circuits described in this and the following sections of this article have all been designed to work with thermistors that present a nominal resistance of 5K0 at the desired operating temperature; all of these circuits will, however, in fact, work well with any n.t.c. thermistors that present a resistance in the range 1K0 to 20K at the required 'trip' temperature.

Figure 3 shows the practical circuit of a simple but very sensitive over-temperature switch that has a relay output. Here, the thermistor (TH1) and RV1-R1-R2 are wired in the form of a simple Wheatstone bridge in which R1-R2 generate a fixed half-supply 'reference' voltage and TH1-RV1 generate a 'variable' output voltage that is inversely proportional to the TH1 temperature and is trimmed (via RV1) so that it almost equals the R1-R2 reference value at the required 'trip' temperature.

These two voltages are fed to the input of the type 741 op-amp which is used — in conjunction with transistor Q1 — as the bridge's balance detector and relay driver. The 741 op-amp is used in the open-loop mode in this circuit, and its action is such that its pin 6 output is driven low (to negative saturation) if its pin 3 (non-inverting) input is more than a few millivolts negative to the pin 2 (inverting) input, and is driven high (to positive saturation) if pin 3 is significantly positive to pin 2.

Suppose, then, that the bridge is adjusted so that it is close to balance at the desired 'trip' temperature. When the temperature falls below this value, the TH1 resistance increases, so the 741's pin 3 voltage rises above that of pin 2, and the pin 6 output voltage thus goes to positive saturation and consequently applies no base drive to Q1; Q1 and the relay are off under this condition.

When the temperature rises above the 'trip' value, however, the TH1 resistance decreases and the 741's pin 3 voltage falls below that of pin 2, and the pin 6 output voltage thus goes to negative saturation and applies heavy base drive to Q1; Q1 and the relay are driven on under this condition.

Thus, the relay goes on when the temperature rises above the preset level, and turns off when the temperature falls below the preset level.

Important points to note about the *Figure 3* circuit are that, because it uses the bridge sensing configuration, its accuracy is independent of variations in supply voltage, and that the circuit can respond to TH1 resistance changes of less than 0.1 percent, i.e., to temperature changes of a fraction of a degree.

Figure 4 shows the above circuit converted into a precision under-temperature switch by simply transposing the op-amp's pin 2 and pin 3 input connections; alternatively, the *Figure 3* circuit can be made to give under-temperature operation by simply transposing the R1 and TH1 positions, or by redesigning the Q1 output stage so that it uses an npn transistor in place of the pnp device.

The *Figure 3* and *4* circuits use a thermistor with a nominal trip-level resistance value of 5K0 as its temperature-sensing element, and this thermistor dissipates several milliwatts of power under actual working conditions.

In some special applications, this power dissipation may cause enough self-heating of the thermistor to upset its thermal sensing capability. In such cases, an alternative type of temperature-sensing device — such as an ordinary silicon diode — may have to be used.

Ordinary silicon diodes have temperature-dependent forward volt-drop characteristics, and can thus be used as temperature-sensing elements. Typically, a silicon diode gives a forward volt drop of about 600mV at a current of 1mA. If this current is held constant, the volt drop changes by about -2mV for each degree Centigrade increase in diode temperature.

All silicon diodes have similar thermal characteristics. Since the power dissipation of the diode is a mere 0.6mW under the above condition, negligible self-heating takes place in the device, which can thus be used as an accurate temperature sensor.

Figure 5 shows how general-purpose silicon diode D1 can be used as a thermal sensing element in an op-amp over-temperature relay-switch circuit. Here, zener

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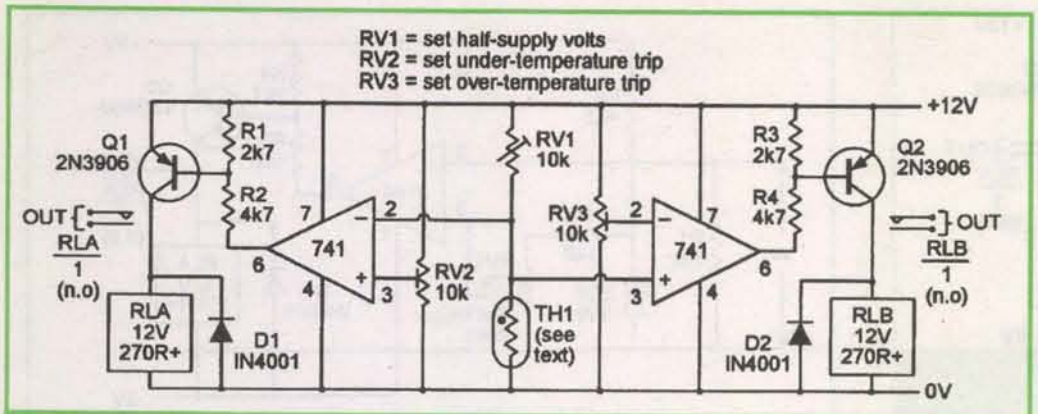

Figure 7. Temperature-deviation switch with independent over/under-temperature relay outputs.

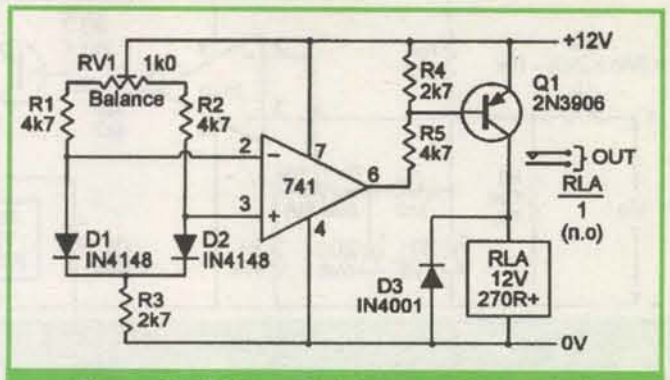

Figure 9. Differential-temperature switch with relay output.

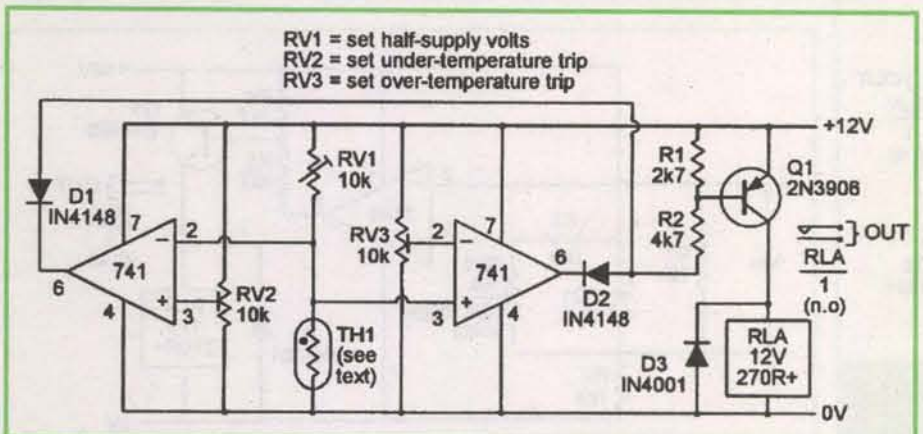

Figure 8. Temperature-deviation switch with single relay output.

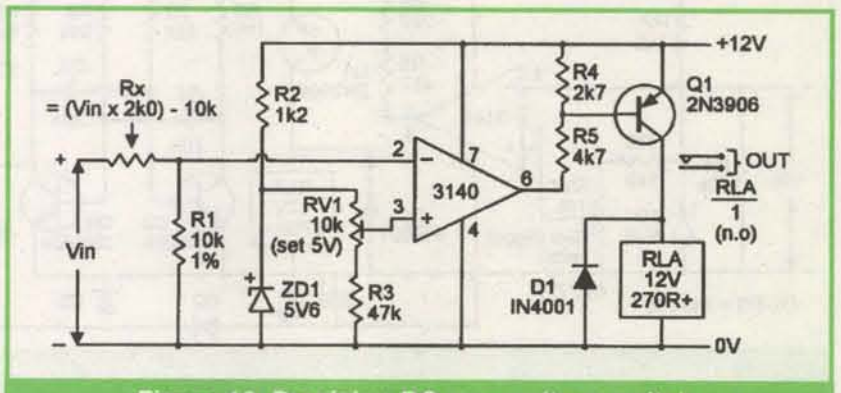

Figure 10. Precision DC over-voltage switch, covering 5V upwards.

diode ZD1 is wired in series with R1 so that a constant 5.6V is developed across the two potential dividers formed by R2-RV1 and R3-D1, and a near-constant current thus flows in each of these dividers.

A constant reference voltage is thus developed between the R1-RV1 junction and pin 2 of the op-amp, and a temperature-dependent voltage with a coefficient of -2mV/°C is developed between the R1-RV1 junction and pin 3 of the op-amp. Thus, a differential voltage with a coefficient of -2mV/°C appears between pins 2 and 3 of the op-amp.

In practice, this circuit is set up by simply raising the temperature of D1 to the required over-temperature trip level, and then slowly trimming RV1 so that the relay just turns on. Under this condition, a differential temperature of about 1mV appears between pins 2 and 3 of the op-amp, the pin 3 voltage being below that of pin 2, and Q1 and the relay are driven on.

When the temperature falls below the trip level, the pin 3 voltage rises above that of pin 2 by about -2mV/°C change in temperature, so Q1 and the relay turn off. The circuit has a typical sensitivity of about 0.5°C, and can be used as an over-temperature switch at temperatures ranging from sub-zero to above the boiling point of water.

Figure 6 shows how the operation of the *Figure 5* circuit can be reversed, so that it functions as an under-temperature switch, by simply transposing the pin 2 and pin 3 connections of the op-amp.

MISCELLANEOUS TEMPERATURE SWITCHES

Each temperature-sensitive circuit shown so far in this article activates when a monitored temperature goes either above or below a preset level. The present section shows three other types of temperature-sensitive security circuit.

Two of these circuits activate relays if the temperature deviates from a preset level by more than a preset amount, and the third activates a relay if two monitored temperatures differ by more than a preset amount. In all cases, the relay(s) can be used to operate any type of electrical alarm or slave device.

Figures 7 and *8* show the circuits of a pair of temperature-deviation switches, which activate if the temperature deviates from a preset level by more than a preset amount. The *Figure 7* circuit has independent over-temperature and under-temperature relay outputs, while the *Figure 8* circuit has a single relay output that activates if the temperature goes above or below preset levels.

Both of these circuits are made by combining the basic over-temperature and under-temperature circuits of *Figures 3* and *4*. The right (over-temperature) half of each circuit is based on that of *Figure 3*, and the left (under-temperature) half is based on that of *Figure 4*.

Both halves of the circuit share a common RV1-TH1 temperature-sensing network, but the under-temperature and over-temperature switching levels of the circuits are independently adjustable.

Each of the two op-amp outputs of the *Figure 7* circuit are taken to independent transistor-relay output stages, while the two op-amp outputs of the *Figure 8* circuit are taken to a single transistor-relay output stage via the D1-D2 gate network. The procedure for

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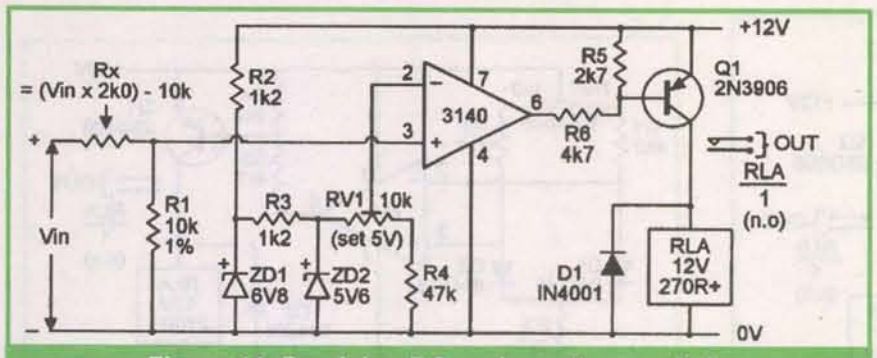

Figure 11. Precision DC under-voltage switch, covering 5V upwards.

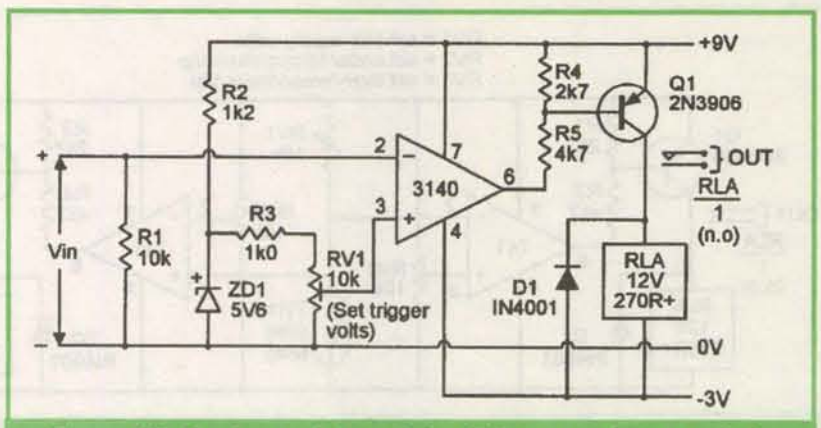

Figure 12. Dual-supply precision DC over-voltage switch, covering 10mV to 5V.

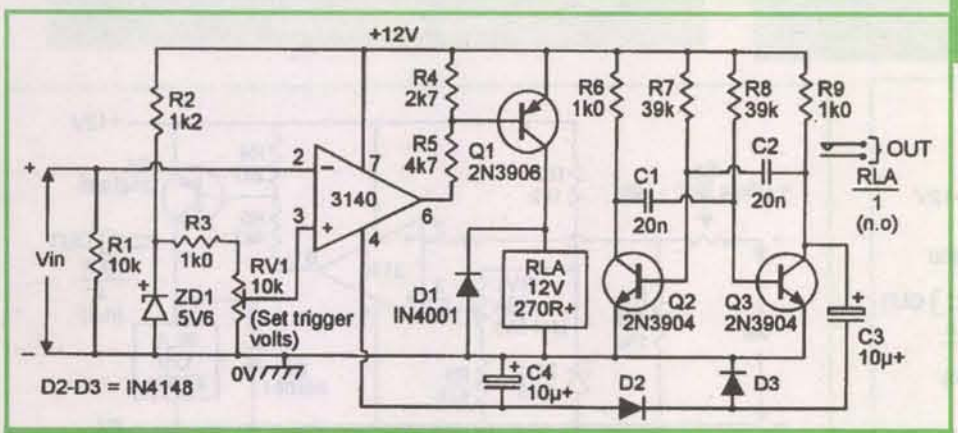

Figure 13. Single-supply precision DC over-voltage switch, covering 10mV to 5V.

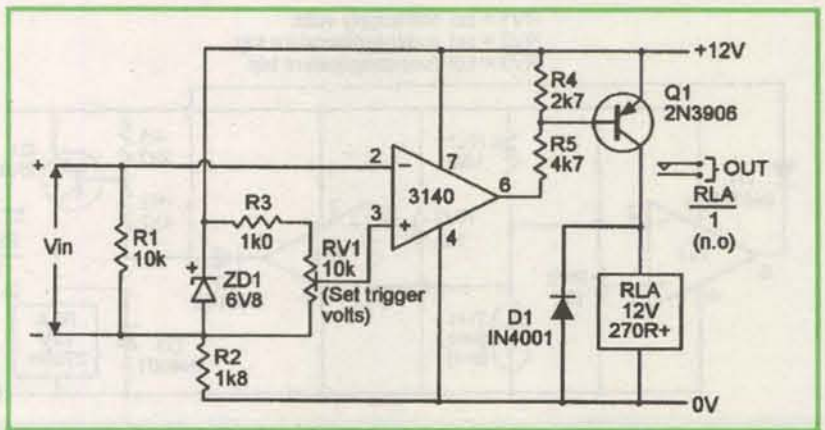

Figure 14. Single-supply DC over-voltage switch, covering 10mV to 5V.

setting up the two circuits is as follows.

First, set RV2 and RV3 to mid-travel, then, with TH1 at its normal or mid-band temperature, adjust RV1 so that half-supply volts are developed across TH1. Now fully rotate the RV2 slider towards the positive supply line, rotate the RV3 slider towards the zero volts line, and check that no 'trip' condition is indicated (relays off).

Next, reduce TH1's temperature to the required under-temperature trip value and adjust RV2 so that the appropriate relay goes on to indicate the 'trip' condition. Now increase the TH1 temperature slightly and check that the relay turns off.

Finally, raise the TH1 temperature to the required over-temperature trip level and adjust RV3 so that the appropriate relay turns on to indicate the 'trip' condition. The circuits are then ready for use.

Figure 9 shows the circuit of a differential-temperature switch that activates a relay if *two* monitored temperatures differ by more than a preset amount. The circuit uses a pair of silicon diodes as temperature-sensing elements, and activates the relay only when the temperature of D1 is more than a preset amount greater than that of D2, and is not influenced by the absolute temperatures of the two diodes.

In this circuit, general-purpose silicon diodes D1 and D2 are used as temperature-sensing elements. A standing current is passed through D1 from the positive supply rail via RV1-R1 and R3, and a similar current is passed through D2 via RV1-R2 and R3. The relative values of these currents can be adjusted over a limited range via RV1, thus enabling the forward volt drops of the diodes to be equalized, so that they give zero differential output when they are both at the same temperature.

Suppose then that the diode voltages have been equalized in this way, so that zero voltage differential exists between them. If now the temperatures of both diodes are raised by 10°C, the forward voltages of both diodes will fall by 20mV, and zero differential will still exist between them. The circuit is thus not influenced by identical changes in the temperatures of D1 and D2.

Suppose next that the temperature of D2 falls 1°C below that of D1; in this case, the D2 voltage will rise 2mV above that of D1, so the op-amp's pin 3 voltage goes positive to that of pin 2, thus driving the op-amp output to positive saturation and holding Q1 and the relay off.

Finally, suppose that the temperature of D2 rises 1°C above that of D1; in this case, the D2 voltage will fall 2mV below that of D1, so the op-amp output goes into negative saturation and drives Q1 and the relay on. Thus, the relay turns on only when the temperature of D2 is above that of D1. The circuit has a typical sensitivity of 0.5°C.

The above explanation assumes that RV1 is adjusted so that the D1 and D2 voltages are equalized when the two diodes are at the same temperature, so that the relay goes on when the D2 temperature rises a fraction of a degree above that of D1. In practice, RV1 is usually adjusted so that the standing bias voltage of

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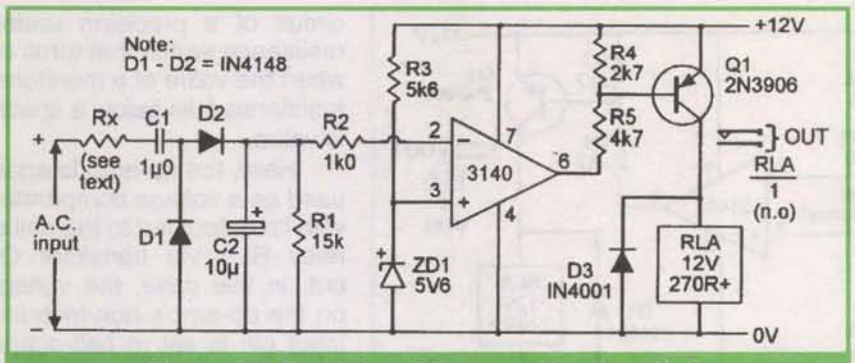

Figure 15. Precision AC over-voltage switch, covering 2.5V upwards.

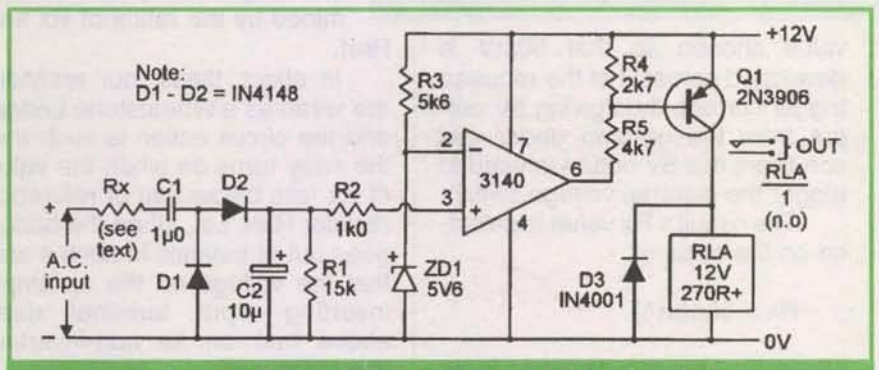

Figure 16. Precision AC under-voltage switch, covering 2.5V upwards.

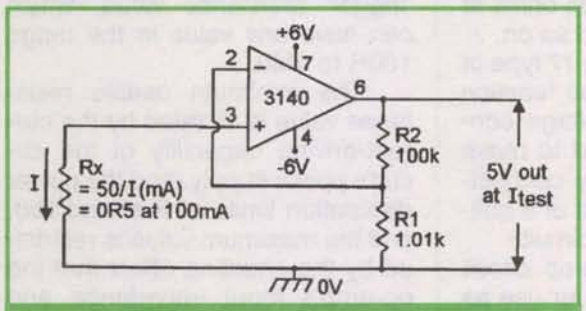

Figure 17. DC current-to-voltage converter.

D2 is some millivolts greater than that of D1 at normal temperatures, in which case, the relay will not turn on until the temperature of D2 rises some where above that of D1.

The magnitude of this differential temperature trip level is fully variable from zero to about 10°C via RV1, so the circuit is quite versatile. The circuit can be set up by raising the temperature of D2 the required amount above that of D1, and then trimming RV1 so that the relay just turns on under this condition.

DC VOLTAGE-ACTIVATED CIRCUITS

Figure 10 shows the practical circuit of a precision DC over-voltage switch that activates only when the input voltage is greater than some pre-set value in excess of at least 5V. Here, the op-amp is used in the open-loop mode as a DC voltage comparator, with a Zener-derived 5V reference applied to the op-amp's non-inverting pin 3 input, and with the test voltage applied between the pin 2 inverting input and ground.

The circuit action is such that the op-amp output is positively saturated, and Q1 and the relay are off, when the pin 2 test voltage is fractionally less than the pin 3 5V reference value, and Q1 and the relay go on when the test voltage is greater than the 5V reference value.

Note in *Figure 10* that Rx is wired in series between the input test voltage and the 10K (R1) impedance of the inverting input of the op-amp, and enables the circuit to be 'ranged' so that it triggers at any required voltage in excess of the 5V reference value. The Rx value for any required trigger voltage is determined on the basis of (2K0 x V) - 10K. Thus, for 50V triggering, Rx = (50 x 2K0) - 10K = 90K. For 5V triggering, Rx must have a value of zero ohms.

The *Figure 10* circuit is very sensitive and exhibits negligible back-lash. Triggering accuracies of 0.5 percent can easily be achieved. For maximum accuracy, either the power supply or the zener reference voltage of the circuit should be fully stabilized.

The *Figure 10* circuit can be made to function as a precision under-voltage switch, which turns on when the input voltage falls below a preset level, by simply transposing the inverting and non-inverting input pin connections of the op-amp, as shown in *Figure 11*.

This circuit also shows how the zener reference supply can be stabilized for high-precision operation. Note in both of these circuits that, once 5V has been accurately set via RV1, the final triggering accuracy is determined solely by the accuracies of Rx and R1. In high-precision applications, therefore, these resistors must be stable high-precision types.

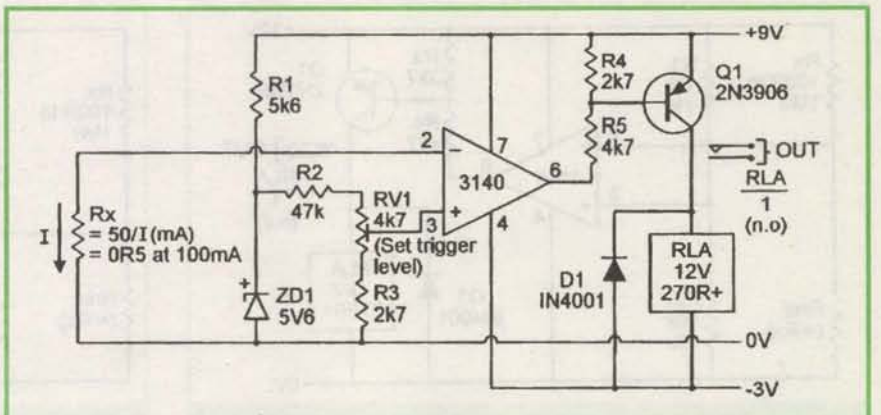

Figure 18. DC over-current switch.

Figure 12 shows how the *Figure 10* circuit can be modified for use as an over-voltage switch covering the range 10mV to 5V. In this case, the input voltage is connected directly to the op-amp's inverting input terminal, and a variable reference voltage is applied to its non-inverting input terminal, and is adjusted to give the same value as that of the required trigger voltage. The circuit action can be reversed, so that the design acts as an under-voltage switch, by transposing the input pin connections of the op-amp. Note that the *Figure 12* circuit uses two sets of supply lines (+9V and -3V), to ensure proper biasing of the op-amp.

Figure 13 shows how the *Figure 12* circuit can be adapted for operation from a single set of supply lines. Here, Q2 and Q3 are wired as an astable multivibrator or squarewave generator, and the output of this generator is used to provide a negative supply rail for the op-amp via the voltage-converting and smoothing D2-D3 and C3-C4 network, which actually gives a negative output of about 9V when unloaded, but this output falls to only 3 to 5 volts when it is loaded by connecting it to the pin 4 'negative supply' terminal of the

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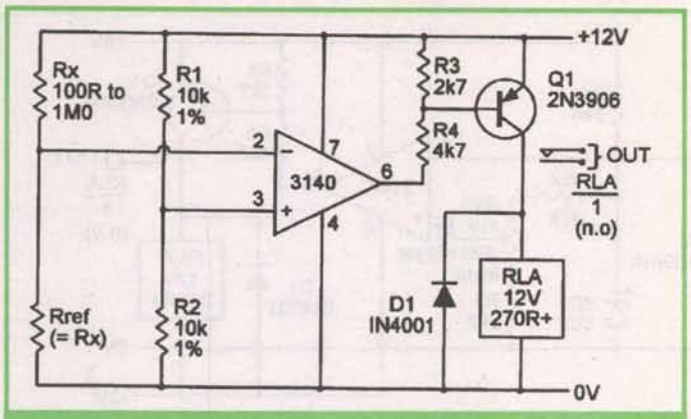

Figure 19. Precision under-resistance switch.

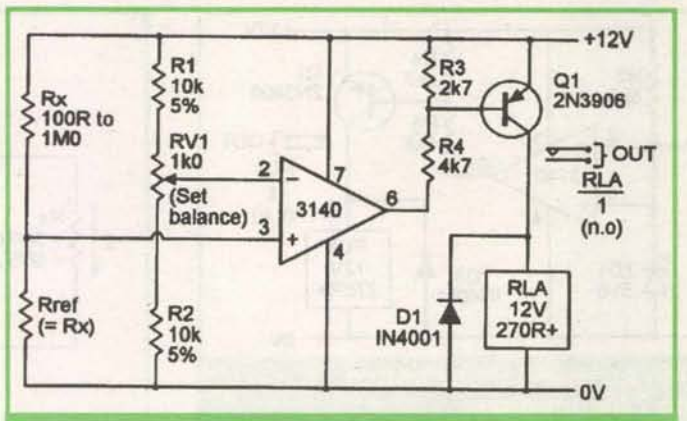

Figure 20. Precision over-resistance switch.

3140 op-amp.

Finally, *Figure 14* shows the circuit of a DC over-voltage switch that covers the range 10mV to 5V and uses a single floating supply. Here, the op-amp is again used as a DC voltage comparator, but its positive supply rail is set at 6.8V via the floating supply and zener diode ZD1, and its negative rail is set at -5.2V via the ZD1 and R2 combination.

The monitored input voltage is fed to the pin 2 inverting input of the op-amp, and the zener-derived reference voltage is fed to the pin 3 non-inverting input of the op-amp via potential divider R3-RV1.

This reference voltage can be varied between roughly 10mV and 5V, and this is therefore the voltage range covered by this over-voltage switch.

AC VOLTAGE-ACTIVATED CIRCUITS

The five voltage-activated switches shown in *Figures 10* to *14* are all designed for DC activation only. All of these circuits can be modified for AC activation by interposing suitable rectifier/smoothing networks or AC/DC converters between their input terminals and the actual AC input signals, so that the AC signals are converted to DC before being applied to the switching circuits.

Figure 15 shows the practical circuit of a precision AC over-voltage switch that is designed to work with sinewave signals in excess of 2.5V RMS. Here, the AC signal is converted to DC via the voltage-converting and smoothing network formed by Rx-C1-D1-D2-C2-R1, and the resulting DC voltage is applied to the pin 2 inverting input of the op-amp via R2.

A zener-derived 5.6V reference voltage is applied to the op-amp's non-inverting input terminal, and the circuit action is such that — when Rx has a value of zero — Q1 and the relay turn on when the DC voltage on pin 2 exceeds 5.6V.

It is important to note in *Figure 15* that the voltage-converting and smoothing network actually gives a DC output voltage that is somewhat less than the *peak* voltage value of a symmetrical sinewave input signal. This type of network cannot be used to measure the RMS values of non-symmetrical or pulse-type waveforms.

Also note that the action of the *Figure 15* circuit can be reversed, so that it acts as an under-voltage switch, by simply transposing the input terminal connections of the op-amp, as shown in *Figure 16*.

The *Figures 15* and *16* circuits both have a basic input impedance — with Rx reduced to zero ohms — of 15K (= R1) and, under this condition, a sinewave of about 2.5V RMS is needed to activate the switch.

Consequently, when Rx is given a finite value, it acts as a potential divider with the 15K input impedance, and enables the circuits to be triggered at any required AC input level in excess of 2.5V.

The Rx value is chosen on the basis of roughly (6K0 x V) - 15K. Thus, if a circuit is to be activated at an input signal level of 10V RMS, Rx must have a value of about 45K.

If required, the effective sensitivities of the *Figure 15* and *16* circuits can be increased, so that they trigger at sinewave input levels substantially less than 2.5V RMS, by simply feeding the AC input signals to the inputs of the switching circuits via fixed-gain transistor or op-amp preamplifiers. Alternatively, the simple AC/DC converters used in these circuits can be replaced by high-gain precision types.

CURRENT-ACTIVATED CIRCUITS

Each of the five DC voltage switch circuits of *Figures 10* to *14* can be used as a DC (power-level) current switch by simply feeding the monitored DC current to the input of the voltage switch via a current-to-voltage converter. A suitable converter circuit is shown in *Figure 17*.

In *Figure 17*, the op-amp is wired as a non-inverting x100 voltage amplifier, with its gain controlled by the ratios of R1 and R2. The test current is passed through input resistor Rx, which has its value chosen so that 50mV is developed across it at the required trigger current, thus giving 5V output from the op-amp under this condition; this 5V output is used to trigger the external voltage switch.

The circuit's Rx value is selected on the basis of

$$Rx = 50/I(mA)$$

where I(mA) is the desired trigger current in milliamps. Thus, Rx needs a value of 0R5 at a trigger current of 100mA, or 0.05 ohms at a trigger level of 1A, and so on.

Note that the *Figure 17* type of converter circuit can also function as an AC current-to-voltage converter, and can be used to make an AC current switch by connecting its output to the input of a suitable AC voltage switch circuit.

If required, an op-amp circuit can be built specifically for use as a DC over-current switch by using the circuit shown in *Figure 18*. Here, Rx is again used to develop 50mV at the desired test current level, and this voltage is applied to the inverting pin of the op-amp.

A zener-derived reference of approximately 50mV is applied to the non-inverting input terminal of the op-amp; this reference voltage can be adjusted over a limited range via RV1, thus providing a limited control of the circuit's sensitivity.

Thus, the *Figure 18* switch circuit's relay turns on when the current-derived input voltage exceeds the 50mV reference voltage. The circuit's action can be reversed, so that it acts as an under-current switch, by simply transposing the op-amp's two input terminal connections. In either case, the value of monitor resistor Rx is chosen on the basis of

$$Rx = 50/I(mA)$$

where I(mA) is the desired trigger current in milliamps. Thus, Rx needs a value of 0R5 at a trigger current of 100mA, or 0.05 ohms at a trigger level of 1A, and so on.

RESISTANCE-ACTIVATED CIRCUITS

Figure 19 shows the practical circuit of a precision under-resistance switch that turns on when the value of a monitored resistance falls below a specific value.

Here, the op-amp is again used as a voltage comparator, with its output fed to the coil of relay RLA via transistor Q1 but, in this case, the voltage on the op-amp's non-inverting input pin is set at half-supply volts via potential divider R1-R2, and the voltage on the inverting input pin is determined by the ratios of Rx and Rref.

In effect, these four resistors are wired as a Wheatstone bridge, and the circuit action is such that the relay turns on when the value of Rx falls below that of reference resistor Rref, i.e., when the bridge goes out of balance in such a way that the voltage on the op-amp's inverting input terminal rises above that on its non-inverting input terminal.

In this circuit, Rref must have the same value of the desired Rx 'trigger' resistance value, which can have any value in the range 100R to 1M0.

The minimum usable resistance value is dictated by the current-driving capability of the circuit's power supply (and the power dissipation limits of Rref and Rx), and the maximum value is restricted by the shunting effect that the op-amp's input impedance and leakage impedance has in the effective value of Rref.

The accuracy of the above circuit is (within sensible limits) quite independent of variations in power-supply voltage, and the 'switch' circuit is capable of responding to changes of less than 0.1 percent in the value of Rx.

The *actual* accuracy of the circuit is determined by the precisions of R1-R2 and Rref, and in worst-case terms is equal to the sum of the tolerances of these three resistors, i.e., it equals ±3% if ±1% percent resistors are used.

The action of the above circuit can be reversed, so that it acts as a precision over-resistance switch, by simply transposing the input pin connections of the op-amp, as shown in *Figure 20*.

This circuit also shows how the basic accuracies of both designs can be improved by adding an RV1 'set balance' control to the R1-R2 potential divider chain.

This control enables the bridge to be very precisely balanced (even when using ±5% R1-R2 components) so that the circuit 'switches' when the value of Rx varies from the marked value of Rref by only ±0.1% or so.

In this case, the true accuracy of the circuit is equal to the tolerance of Rref +0.1%. **NV**

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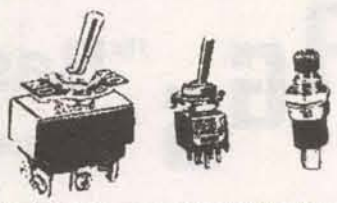

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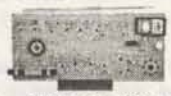

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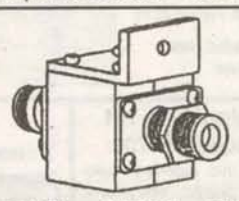

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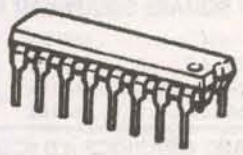

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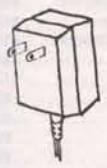

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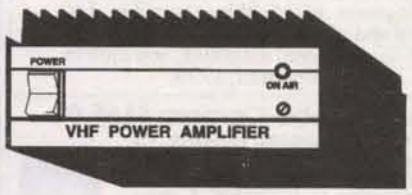

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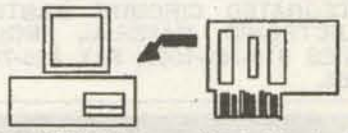

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Black and white board-level ccd camera is small but mighty. The whole thing measures a tiny 1.5"x1.5"x0.75". Operates on 9-12 VDC with adjustable lens. Features an infra-red LED boarder for viewing 'in the dark'...forget those night vision goggles!

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Watch late night TV without disturbing anyone! This video viewing system can be connected to your vcr and you can watch (and hear) your program on the headset! Of course, it is not like the picture on that 12 foot big screen at the local sports pub, but you can watch in your jammies and see who the guests are on your favorite late night talk show!
Play your favorite video games arcade style! Designed for use with many Super NES and Sega Genesis games, the headset has both audio and motion sensing capabilities. Generally speaking, this is ideal for racing, flight, and tank simulators with a first person or rear view perspective, and games with an eye level perspective. System features volume control, sensitivity control, brightness control, tint control, as well as a reset button and mode switches to select your application. Composite video headset system includes headset, tracking tube (for motion sensing), AC adapter, Super NES cable assembly and Sega Genesis cable assembly. A pinout is also included for TV/VCR viewing.

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Super Pro FM Stereo Radio Transmitter

A truly professional frequency synthesized FM Stereo transmitter station in one easy to use, handsome cabinet. Most radio stations require a whole equipment rack to hold all the features we've packed into the FM-100. Set frequency easily with the Up/Down freq buttons and the big LED digital display. Plus there's input low pass filtering that gives great sound no matter what the source (no more squeals or swishing sounds from cheap CD player inputs!) Peak limiters for maximum 'punch' in your audio - without over modulation, LED bargraph meters for easy setting of audio levels and a built-in mixer with mike and line level inputs. Churches, drive-ins, schools and colleges find the FM-100 to be the answer to their transmitting needs, you will too. No one offers all these features at this price! Kit includes cabinet, whip antenna and 120 VAC supply.

We also offer a high power export version of the FM-100 that's fully assembled with one watt of RF power, for miles of program coverage. The export version can only be shipped outside the USA, or within the US if accompanied by a signed statement that the unit will be exported.

FM-100, Professional FM Stereo Transmitter Kit.....$299.95
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AM Band Radio Transmitter

Ramsey AM radio transmitters operate in the standard AM broadcast band and are easily set to any clear channel in your area. Our AM-25, 'pro' version, fully synthesized transmitter features easy frequency setting DIP switches for stable, no-drift frequency control, while being jumper setable for higher power output where regulations allow. The entry-level AM-1 uses a tunable transmit oscillator and runs the maximum 100 milliwatts of power. No FCC license is required, expected range is up to 1/4 mile depending upon antenna and conditions. Transmitters accept standard line-level inputs from tape decks, CD players or mike mixers, and run on 12 volts DC. The Pro AM-25 comes complete with AC power adapter, matching case set and bottom loaded wire antenna. Our entry-level AM-1 has an available matching case and knob set for a finished, professional look.

AM-25, Professional AM Transmitter Kit.....$129.95
AM-1, Entry level AM Radio Transmitter Kit.....$29.95
CAM, Matching Case Set for AM-1.....$14.95

CCD Video Cameras

If you're looking for a good quality CCD board camera, stop right here! Our cameras use top quality Japanese Class 'A' CCD arrays with over 440 line line resolution, not the off-spec arrays that are found on many other cameras. You see, the Japanese suppliers grade the CCDs at manufacture and some manufacturers end up with the off-grade chips due to either cost constraints or lack of buying 'clout'. Also, a new strain of CMOS single chip cameras are entering the market, those units have about 1/2 the resolution and draw over twice the current that these cameras do - don't be fooled! Our cameras have nice clean fields and excellent light sensitivity, you'll really see the difference, and if you want to see in the dark, the black & white models are super IR (Infra-Red) sensitive. Our IR-1 Illuminator kit is invisible to the human eye, but lights the scene like a flashlight at night! Color camera has Auto White Balance, Auto Gain, Back Light Compensation and DSP! Available with Wide-angle (80°) or super slim Pin-hole style lens. They run on 9 VDC and produce standard 1 volt p-p video. Add one of our transmitter units for wireless transmission to any TV set, or add our IB-1 Interface board for audio sound pick-up and super easy direct wire hook-up connection to any Video monitor, VCR or TV with video/audio input jacks. Cameras fully assembled, including pre-wired connector.

CCDWA-2, B&W CCD Camera, wide-angle lens.....$99.95
CCDPH-2, B&W CCD Camera, slim fit pin-hole len.....$99.95
CCDPH-2, Color CCD Camera, wide-angle lens.....$149.95
IR-1, IR Illuminator Kit for B&W cameras.....$24.95
IB-1, Interface Board Kit.....$24.95

FM Stereo Radio Transmitters

Microprocessor controlled for easy frequency programming using DIP switches, no drift, your signal is rock solid all the time - just like the commercial stations. Audio quality is excellent, connect to the line output of any CD player, tape deck or mike mixer and you're on-the-air. Foreign buyers will appreciate the high power output capability of the FM-25; many Caribbean folks use a single FM-25 to cover the whole island! New, improved, clean and hum-free runs on either 12 VDC or 120 VAC. Kit comes complete with case set, whip antenna, 120 VAC power adapter - easy one evening assembly.

FM-25, Synthesized FM Stereo Transmitter Kit.....$129.95

A lower cost alternative to our high performance transmitters. Offers great value, tunable over the 88-108 MHz FM broadcast band, plenty of power and our manual goes into great detail outlining aspects of antennas, transmitting range and the FCC rules and regulations. Connects to any cassette deck, CD player or mixer and you're on-the-air, you'll be amazed at the exceptional audio quality! Runs on internal 9V battery or external power from 5 to 15 VDC. Add our matching case and whip antenna set for a nice finished look.

FM-10A, Tunable FM Stereo Transmitter Kit.....$34.95
CFM, Matching Case and Antenna Set.....$14.95
AC12-5, 12 Volt DC Wall Plug Adapter.....$9.95

RF Power Booster

Add some serious muscle to your signal, boost power up to 1 watt over a frequency range of 100 KHz to over 1000 MHz! Use as a lab amp for signal generators, plus many foreign users employ the LPA-1 to boost the power of their FM Stereo transmitters, providing radio service through an entire town. Runs on 12 VDC. For a neat, professionally finished look, add the optional matching case set.

LPA-1, Power Booster Amplifier Kit.....$39.95
CLPA, Matching Case Set for LPA-1 Kit.....$14.95
LPA-1WT, Fully Wired LPA-1 with Case.....$99.95

Treasure Finder Kit

Search for buried treasure at the beach, backyard or park. This professional quality kit can detect metal at a depth of up to 6 inches. Easy to use, just listen for the change in tone as you 'sweep' the unit across the surface - the larger the tone change - the larger the object. Has built-in speaker or earphone connection, runs on standard 9 volt battery. Complete kit includes handsome case, rugged PVC handle assembly that 'breaks down' for easy transportation and shielded Faraday search coil. Easy one evening assembly. This nifty kit will literally pay for itself! That guy in the picture looks like he found something - what do you think it is - gold, silver, Rogaine, Viagra? You'll have fun with this kit.

TF-1, Treasure Finder Kit.....$39.95

Binocular Special

We came across these nice binoculars in an importers close-out deal. Not some cheap in-line lens jobs, these beauties have roof prisms, a super nice rubber armored housing over light weight aluminum. 10 x 25 power with fully coated optics. Includes lens cleaner cloth, neck lanyard and nice carry case. For extra demanding use in bright sun, choose the EX module with ruby coated Objective lens. First quality at a close-out price! We've seen the exact same units with the 'Bushnell' name on them being sold for $30 more!

BNO-1, Binoculars and case.....$24.95
BNO-1EX, Ruby Coated Lens Binoculars and case.....$29.95

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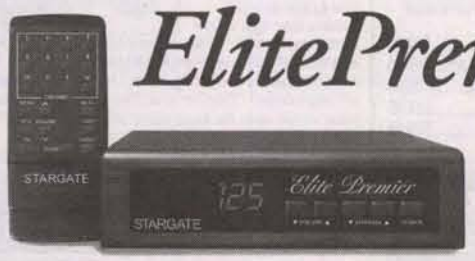

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Service Manuals and Schematics

It is infinitely easier to calibrate test equipment or fix consumer electronics whenever you have the exact service literature available. A lot of this info can be hard to pin down. Especially older gear from companies who have folded or merged. But there's all sorts of oddball insider sources when you know just where to look.

An obvious starting point can be all those manual and service lit ads right here in *Nuts & Volts Magazine*. Other places to check are *Electronic Servicing*, *Computer Service and Repair*, *Antique Radio Classified*, *Recharger*, and *Compu-Mart*. Web newsgroups include ...

fido.7.mo.hardw-repair
misc.industry.electronics
sci.electronics.design
sci.electronics.equipment
sci.electronics.misc
sci.electronics.repair
sci.electronics.test

The actual manufacturers often are not that great a place to go for service info. They only go back so far and do tend to have outrageous charges for useful info. But you always might want to try *Tektronix*, *Hewlett-Packard*, *B & K*, *Fluke*, and other test equipment sources on your first attempt.

A list of some used test equipment sources appears in MUSE129.PDF on my *www.tinaja.com*. Many times, these folks will have just the manual you need. Note that it is not unusual for the service manual for a piece of used test equipment to cost *much more* than the gear itself.

Let's look at three unique electronic service sites, followed by a rundown of the major and minor players in the repair and schematics field ...

Sci.Electronics.Repair FAQ

This great place to start off is run by the leading *Usenet* newsgroup on electronic repairs. Pages on *Sources for Manuals/Schematics* and their *Sources for Obsolete ICs/Parts* are enormously useful. Their main url is *www.repairfaq.org/REPAIR/F_Repair.html*.

NEXT MONTH:
Don reveals major new opportunities in mil surplus electronics.

Notes on TV Repair & Diagnosis

Do check out this really informative site you should be able to link to at *www.eng.usm.my/~musa/html/tv.html*. Besides all those detailed manual and service info source listings, they have dozens of pages on everything from TV troubleshooting to color balance to instant-on to pincushion adjustments to setup menus.

Their pages on *Repair Information & Parts Sources* and *Service Manuals for Really Old TVs* are quite useful.

These pages are most worthwhile.

Radio Era Archives

This exceptionally impressive web site is up at *www.electrosys.com/rea.htm*.

They have dedicated themselves to preserving the past age of great old radio books by re-publishing them on CD-ROM. There's over 5,000 old book resources, plus ham and test manuals, stories on repair and restoration, and bunches more.

Such as the radio schematics in two volumes from 1915 to 1945 and 1946 to 1963. Lots of original ham and other manuals are stocked. Along with the links to other old radio sites.

By the Numbers

Here's most the rest of the gang ...

Antique Audio — They do carry older factory manuals for Zenith, RCA, and others. Also Beitman's and Sams. The costs start at $5.00 per schematic or docs to eight pages, 50 cents beyond.

Antique Electronics Supply — Sells pre-1960's service manuals for electronics and ham receivers. Prices start at $4.50 and increase for longer docs.

Alton Bowman — This eclectic source has everything from garage doors to electronic organs. They specialize in the 1920 to 1970 era. Typical schematic reprints are $5.00 and up.

Ardco Electronics — The Hallicrafter's manual source run by the son of their service manager out of Illinois. Prices range from $7.00 to $20.00.

Diverse Devices — British outfit which targets used test gear, schematics, and pinouts. Jolly good show.

Fair Radio Sales — Still at their same old stall after all these years. They handle all WWII and newer military surplus. Often, full manuals, partial manuals, and a few reprints may be available at reasonable prices. But inventory is catch-as-catch-can.

Allen Fulmer — A Florida site which specializes in the big three of Fluke, HP1, and Tektronix. The Tek doghouse scope manuals are $20.00, plug-ins $5.00. Lots of newer stuff is available. Also buys and sells used test equipment manuals.

Don Beehler — Source for out-of-print ham manuals which includes Drake, Hammarlund, Hallicrafters, and a few others. Several mil surplus manuals. Pricing from $2.00 to $12.00 each.

Walter Besitolj — Long-time source for manuals for vintage ham radio, test equipment, CB, and military stuff. His E-Mail is *klrts@juno.com*.

Bomarc Services — Wyoming outfit supplies reverse engineering services. A backlist includes many thousands of devices at reasonable prices. Also offers circuit tracing and analysis on a contract or custom basis.

G. Cain — Reprints the US Army tech manuals for radio equipment made from 1940 to 1979. Cost is a quarter per page. Also have master directories and surplus search info available.

Philip Carpenter — Has got ham radio operation and service

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(419) 223-2196

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PO Box 9090
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(800) 443-5853

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2538 Sweetgum Way W
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(813) 796-3424

Garcia, Bob
845 Fairfield Dr
Marietta GA 30068
(770) 977-5701

Griffiths, Stan
18955 SW Blanton St
Aloha OR 97007
(503) 649-0837

HAManuals
29926 SE 408th St
Enumclaw WA 98022
(360) 825-1167

Heathkit Manuals
PO Box 1288
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3583 Everett Rd
Richfield OH 44286
(330) 659-3244

Hewlett-Packard Manuals
PO Box 1145-Mail Order
Roseville CA 95678
(800) 752-0900

Hi-Manuals
Al McMillan
PO Box 802
Council Bluffs IA 51502

Kakstys, John
18 Hillcrest Terrace
Linden NJ 07036
(908) 486-6917

Kidd, Deane
27270 SW Ladd Hill Rd
Sherwood OR 97140
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Kimber Manuals
KingsRow Estates #12
Washington UT 84780
(801) 634-0760

Lindsay Pubs
PO Box 538
Bradley IL 60915
(815) 935-5353

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27 Walling St
Sayreville NJ 08872
(908) 238-8964

Manual Merchant
PO Box 927792
San Diego CA 92192
(619) 642-0785

Manuals Plus
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Tooele UT 84074
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Troy OH 45373
(937) 335-4560

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Wheeling IL 60090
(708) 634-6467

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Herndon VA 20172
(703) 716-1363

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Silver Spring MD 20910
(301) 585-8776

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131 Ridge Rd
W Milford NJ 07480
(973) 728-2454

Probe Master
215 Denny Way
El Cajon CA 92020
(800) 772-1519

Puett Electronics
PO Box 28572
Dallas TX 75228
(214) 321-0927

Radio Era Archives
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Dallas TX 75235
(214) 358-5195

Recharger
4218 W Charleston Blvd
Las Vegas NV 89102
(702) 438-5557

Sams, Howard W Co
3647 Waterfront Pkwy E Dr
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6147 Via Serena St
Alta Loma CA 91701
(800) 413-1129

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Otto NC 28763
(704) 524-7519

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7519 Maplewood Ave
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(219) 931-9316

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Tektronix
PO Box 500
Beaverton OR 97077
(800) 835-9433

Test Equipment Manuals
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(619) 479-0225

Thompson, Don
20650 Prairie St
Chatsworth CA 91311
(800) 423-5400 X2537

Tucker Electronics
1717 Reserve St
Garland TX 75042
(800) 527-4642

US Army Military History Institute
Carlisle Barracks PA 17013
(717) 245-3611

US Surplus
PO Box 37
Ellicott City MD 21041
(410) 750-1083

W7FG Vintage Manuals
402731 W 2155 Dr
Bartlesville OK 74006
(918) 333-3754

Western Nebraska Elec
HC-84, Box 1
Potter NE 69156
(308) 879-4552

manuals from Aea to Yaesu. Provides a free search service. *richcarp@worldnet.att.net.*

Compass Electronics Supply — Stocks military surplus tech manuals.

David Crowe — Stocks hundreds of manuals and schematics.

Jim Farago — Complete sets of Rider Manuals that cover radios from 1924 to 1954 Cost is $3.00 per copy.

Feitek — Buys and sells lots of used test equipment manuals.

Bob Garcia — A long retired Tektronix engineer who is very much an expert in scope repair and manuals. He also rebuilds and resells older Tek scopes on the hamfest circuit.

Marty Gasman — Marty focuses on old audio repairs and owner's manuals, along with original suppliers lit. Web site is *www.tiac.net/users/mgasman.* He also does some closeout and odd lot computer sales. Apparently prefers to work with E-Mail only, as I could not find his address or phone number.

Stan Griffiths — Stan both authors and publishes his *Oscilloscopes — Restoring a Classic* book on early Tek scopes and is a leading authority. Especially on all the Tek vacuum tube "doghouse" series. More info at *www.tinaja.com/amlink01.html.*

Grimm's Manuals On-line — Has ham radio reprints of Hallicrafters, Drake, E.F. Johnston, and others. Welcomes all GIF or JPG1 scanned contributions. Access is via *ftp://198.28.36.115.*

Ham Manuals — Source of collected ham radio manuals on CD-ROM.

Hammarlund Guy — Stocks Collins and Hammarlund manuals.

Heathkit — Genuine Heath manuals do remain available by way of *Heathkit Educational Systems.* These once were a superb way to scope out how things worked and how circuits operated. Much of it is now, of course, dated.

Nick Hersey — Sells TM and lots of other military manuals.

Steve Hevener — Provides his WWII military radio catalog; has surplus manuals and lots of historical info.

Hi-Manuals — Commercial, radio, and ham manuals from the 1930s to the 1970s. Also resells Sams Photofacts, Heathkit manuals, and RCA tube stuff. Provides data on any tube for $5.00.

John Kakstys — Sells ham radio and other manuals.

Dean Kidd — A retired Tek engineer who apparently has a mountain of older and impossible-to-find parts. He also sells older Tektronix manuals. I got a transformer here for a TM series mainframe. Reasonable price and it worked like a champ.

Steve Kimber Manuals — Stocks ham radio gear manuals.

Lindsay Publications — Lindsay has all sorts of "new old" books covering everything from "lost" machine shop technology to his antique and classic radio schematics. Start off with their *Radio for the Millions* book.

The Manual Man — A labor-of-love operation from Pete Markavage who has manuals for both new and older test gear. Also has amateur, audio, and radio listings.

Manual Merchant — Buys and sells used test equipment manuals.

Manuals Plus — This Utah source has thousands of service and operational manuals of all types of old test and measurement equipment from the 1950s to present. Contact here is Jack House. Covers all the majors and some of the more obscure sources.

Mecca — They stock used manuals for test equipment, ham shack stuff, and early radios. Pricing is $5.00 to $35.00.

MI Technologies — Call themselves the monitor and computer schematic info experts. They'll also do some reverse engineering on monitors, CPUs, and power supplies. Also offer a *Monitor Wizard* software package that includes over 800 schematic diagrams.

Mike Nowlen — Trades test equipment manuals and hi-fi service info. His website is *mnowlen@cwi.net.*

Musty Manuals — Extensive collection of owners, service, and a few maint manuals, plus some early magazines. Has a nice catalog available.

Old Tyme Radio Co — Uh, before Sams was Riders. These folks stock reprints of early Riders manuals for antique and classic radios. Along with RCA tube manuals and such.

Chuck Penson — Has got lots of old Heathkit manuals. Visit his web site at *comped.sci.mus.mn.us.*

Richard Prester — Sells amateur radio and other manuals.

Probemaster — These folks make low-cost probes, scopes, and general use. They can replace more expensive Tek or HP probes and are nearly as good. A typical 10X scope probe might cost $27.00, or under half that of Tek list.

An aside for a few obvious tips here: Be sure your scope probe gets matched to your input! Typical 10X1 probes expect something like a one meg input and 15 picofarads or so. Certain fancy high frequency plug-ins for premium scopes (a Tek 7A24 ferinstance) may have 50-ohm inputs instead. *A regular probe will not work with one of these!* Further, any probe will have a twist or screw adjustment that can *calibrate* or adjust its high-frequency response. Calibration gets done by forcing a squarewave flat across its top. *Once calibrated, scope probes must never be interchanged or swapped around!*

Continuing down our list ...

Puett Electronics — Schematics for most any radio receiver at $5.00 for the bare schematic and $15.00 for more detailed docs. Has Rider indexes. Mostly on classic radio plus some amateur and test equipment. Also stocks antique radio parts and old radio shows.

Howard W. Sams — Long the definitive source for TV repair info. Also radios, VCRs, CB sets, and some computers and manuals. Arranged in *Photofact* packets with schematics and service info. But used is cheaper.

Raymond Sarrio — Whose website is *www.sario.com*. This California firm specializes in vintage radio manuals. Web pages cover *AEA* to *Hammarlund*, *Hamtronics* to *Kenwood*, and *KLM* to *Zenith*. Includes some mainstream test instruments as well.

Slep Electronics — Has got service and operation manuals for amateur radio, mil surplus, commercial test gear, and antique radio. A fairly impressive collection can be found here.

Steimetz Electronics — Has Riders and Beitman books on earlier radios and Sam's Photofacts. Prices start at $3.00 for available schematics.

Jim Tannenbaum — This highly useful repair and service manual source also stocks used Sams Photofacts. Typical prices are $5.00 for an older TV photofact, and $7.00 for newer ones. Also has the original and Sams VCR manuals.

Tech Systems Electronics — Buys and sells used test equipment manuals.

Test Equipment Manuals — Used real service and operating manuals for Tek and HP. Costs are typically in the $15.00 range. This one gets run by Ed Matsuda in California.

Don Thompson — Don offers superb laser printer service training and lots of repair parts, along with original laser printer service manuals from *Hewlett Packard* and others. His videos and manuals are outstanding

Tucker Electronics — One of the higher profile refurbished test gear outfits, they can be a useful source for owner and service manuals on older test gear. An extensive list of similar firms at *www.tinaja.com/glib/muse129.pdf*.

US Army Military History Institute — Has tech manuals for mil radio stuff. Offers interlibrary loan. Reprints are $6.00 for the first 10 pages of a manual, plus a quarter per page beyond that.

US Surplus — Buys, trades, and sells electronic test equipment manuals.

Western Nebraska Electronics — Stocks complete set of early Collins radio manuals. Price is $12.50 per reprint. Also has lots of early Collins parts.

W7FG Vintage Manuals — Site carries over 4,000 manuals, mostly on ham gear test equipment, both old and new. Also a few antique radio books, components, and projects. The web site is *eigen.net/w7fg*. Included are lots of links to other manual sites.

Some Books

Some additional useful links on these topics can be newly found at *www.tinaja.com/eeweb01.html* and my *www.tinaja.com/dtkwb01.html*. I have gathered together several books on electronic servicing and related topics at *www.tinaja.com/amlik01.html*.

This Month's Contest

Once again, I have a feeling I may have missed one or two biggies in the used manual field. Those names and websites and phone numbers also have a way of rapidly coming and going. So, for this month's contest, just tell me about some electronic service manual resource that I may have missed or gotten wrong.

There should be a largish pile of my new *Incredible Secret Money Machine* books going to the dozen or so better entries, plus an all-expense-paid (FOB Thatcher, AZ) *tinaja quest* for two that will go to the very best of all.

To be fair to everyone, all entries must be written and submitted via snail mail. Send all your *written* entries to me here at *Synergetics*, rather than to *Nuts & Volts* editorial.

Let's hear from you. **NV**

Microcomputer pioneer and guru Don Lancaster is the author of 35 books and countless tech articles. Don maintains his no-charge US tech helpline found at ***(520) 428-4073****, besides offering all of his own books, reprints, and consulting services. Don also offers a free catalog full of his unique products and resource secrets. The best calling times are 8-5 on weekdays, Mountain Standard Time*

Don is the webmaster of his Guru's Lair found at ***http://www.tinaja.com/tinaja****. Full reprints and preprints of all Don's columns and ongoing tech support appear here. You can reach Don at Synergetics, Box 809, Thatcher, AZ 85552. Or send any messages to* ***don@tinaja.com****.*

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Fluke 332B, DC Voltage Standard ... $475
Fluke 335A, DC Voltage Standard ... $475
Fluke 382A, Voltage/Current Calibrator ... $525
Fluke 540B, Transfer Standard w/A54-2 Voltage Plug-in ... $625
Fluke 721A, Lead Compensator ... $275
Fluke 760A, Meter Calibrator ... $450
Fluke 845AB, Null Detector/Micro Voltmeter 1uV-1000VDC ... $375
Fluke 845AR, Null Detector/Micro Voltmeter 1uV-1000VDC ... $375
Fluke 893A, AC/DC Differential Voltmeter 0 to 1100 Volts, AC/DC, .01%DC, .05%AC, 1uV Resolution ... $100
Fluke 3330B, Constant Current/Voltage Calibrator ... $675
Fluke 5100B, Multifunction Calibrator, Opt. 03/05 ... $3,250
Fluke 5100B, Multifunction Calibrator ... $2,700
Fluke 5200A, Programmable AC Calibrator ... $1,250
Fluke 5215A, Precision Power Amp ... $950
Fluke 6011A, Synthesized Signal Generator, 10Hz-11MHz (7-digit) ... $825
Fluke 6070A, Synthesized RF Signal Generator 200KHz-520MHz ... $1,500
Fluke 8000A, DMM 3-1/2 Digit ... $75

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Fluke 8600A, DMM 4-1/2 Digit w/o Battery Pack ... $125
Fluke 8800A, DMM 5-1/2 Digit ... $175
General Radio 1390-B, Random Noise Generator ... $150
General Radio 1346, Audio Frequency Micro Voltmeter ... $125
Gould K105-D, Logic Analyzer w/4 Probe Pods ... $650
Guildline 9770B, Constant Current Source ... $125
HP 141T, Spectrum Analyzer Mainframe ... $475
HP 141T, Spectrum Analyzer w/8552A/8553B, 1KHz-110MHz ... $1,000
HP 141T, Spectrum Analyzer w/8552B/8553B, 1KHz-110MHz ... $1,200
HP 141T, Spectrum Analyzer w/8552B/8556A, 20Hz-300KHz ... $1,100
HP 141T, Spectrum Analyzer w/8552B/8554B, 1KHz-1.2GHz ... $1,700
HP 141T, Spectrum Analyzer w/8552B/8555A, 10MHz-18GHz ... $1,900
HP 180TR, Scope Mainframe ... $250
HP 214A, Pulse Generator, .08V-100V ... $250
HP 334A, Distortion Analyzer ... $275
HP 350D, Attenuator ... $75
HP 400EL, AC Voltmeter, 10Hz-10MHz ... $150
HP 400FL, RMS Voltmeter, 20Hz-4MHz, 100uV-300V ... $175
HP 403B, AC Voltmeter Battery Operated, 5Hz-2MHz, 1mV-300V ... $175
HP 415E, SWR Meter ... $100
HP 427A, Multi-function Meter (AC, DC & Resistance 10Hz-1MHz) ... $100
HP 432A, Power Meter w/Cable/B478, .01-18GHz Sensor ... $350
HP 432A, Power Meter w/o Cable/Sensor ... $250
HP 435A, Power Meter w/o Sensor/Cable ... $175
HP 651B, Test Oscillator, 10Hz-10MHz ... $150
HP 652B, Test Oscillator, 10Hz-10MHz ... $150
HP 654A, Oscillator, 10Hz-10MHz, 90dB Attenuator ... $225
HP 1630D, Logic Analyzer w/pods ... $550
HP 1980B, Scope Measurement System w/1965A Gated Universal Timer (like new) ... $550
HP 3312A, Function Generator, .1Hz-13MHz ... $490
HP 3325A, Programmable Frequency Synthesizer 1Hz-32MHz ... $1,650
HP 3330B, Automatic Synthesizer, 20Hz-13MHz ... $325
HP 3400A, True RMS Voltmeter, 10Hz-10MHz, 1mV-300V ... $200
HP 3403C, True RMS Meter, AC/DC/dB 100MHz ... $325
HP 3406A, RF Voltmeter, 50uV-3V, 1.2GHz ... $350
HP 3455A, DMM 5-1/2 Digit ... $250
HP 3456A, DMM 6-1/2 Digit ... $525
HP 3466A, DMM 4-1/2 Digit, AC/Battery, 5 Function ... $225
HP 3467A, Logging Voltmeter ... $225
HP 3580A, Spectrum Analyzer, 5Hz-50KHz, LED Readout ... $850
HP 3581A, Wave Analyzer, 15Hz-50KHz ... $475
HP 3762A, Data Generator, 30-150MHz ... $450
HP 3770A, Amplitude/Delay Distortion Analyzer ... $425
HP 3779B, Primary MPX Analyzer ... $625
HP 3781B, Pattern Generator ... $300
HP 5314A, Counter/Timer, 100MHz (unused) ... $175
HP 5328A, Counter, 100MHz w/DVM/Opt. 021 ... $250
HP 5328A, Counter, 500MHz ... $350
HP 5345A, Counter, 500MHz, HP-IB ... $450
HP 6104A, Precision Power Supply, 20V @ 3A, 20-40V @ 1A (metered) ... $175
HP 6112A, Power Supply, 40V @ .5A (metered) ... $175
HP 6116A, Power Supply, 0-100V @ 200mA (metered) ... $125
HP 6202B, Power Supply, 40V @ .75A (metered) ... $175
HP 6203B, Power Supply, 7.5V @ 3A (metered) ... $175
HP 6205B, Power Supply (dual), 0-40V @ .3A, 0-20V @ 8A (metered) ... $225
HP 6206B, Power Supply, 0-60V @ 1A (metered) ... $250
HP 6253A, Power Supply (dual), 0-25V @ 3A (metered) ... $225
HP 6260B, Power Supply, 10V @ 100A (metered) ... $400
HP 6265B, Power Supply, 40V @ 3A (metered) ... $250
HP 6266A, Power Supply, 40V @ 6A (metered) ... $250
HP 6289A, Power Supply, 0-40V @ 1.5A (metered) ... $225
HP 6294A, Power Supply, 0-60V @ 1A (metered) ... $275
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HP 8013B, Pulse Generator, 1Hz-50MHz ... $275
HP 8015A, Pulse Generator, .1Hz-50MHz 30V ... $425
HP 8081A, Rate Generator (300MHz) w/8084A Word Generator (300MHz) w/8083A Output Amp (300MHz) ... $950
HP 8091A, Rate Generator (1GHz) w/8092A Delay Generator (1GHz) w/8093A Output Amp w/15401A & 15400A ... $3,000
HP 8165A, Programmable Sig Source, 1milliHz-50MHz ... $950
HP 8180A, Data Generator ... $425
HP 8182A, Data Analyzer ... $650
HP 8410B, Network Analyzer Mainframe ... $275
HP 8414A, Polar Display ... $225
HP 8443A, Tracking Generator w/Cables, 1KHz-110MHz ... $475
HP 8444A, Tracking Generator for 141T System, .5-1300MHz ... $750
HP 8553B, RF Plug-in (for 140 Series Mainframes), 1KHz-110MHz ... $425
HP 8553L, RF Plug-in (for 140 Mainframes), use with 8552A, 1KHz-110MHz ... $125
HP 8601A, Sweeper Generator, .1-110MHz ... $425
HP 8614A, Signal Generator, 800-2400MHz, AM/FM Leveled ... $475
HP 8616A, Signal Generator UHF, 1.8-4.5GHz, +10-128dB, AM/FM ... $475
HP 86242D, RF Plug-in, 5.9-9.0GHz ... $350
HP 8640B, Signal Generator, .5-1050MHz, Opt. 002/001 or 003 ... $1,800
HP 8640B, Signal Generator, .5-512MHz, Opt 001 or 003 ... $950
HP 8743A, Reflection Test Set, 2-12.4GHz ... $475
HP 8901A, Modulation Analyzer ... $2,400
HP 59303A, D/A Converter ... $175
HP 59501A, HP-IB Isolated D/A Converter ... $125
Huntsville 80-D, Micro Systems Troubleshooter ... $225
Huntsville 180P, Micro Systems Troubleshooter ... $350
Kepco ATE15-50M, Power Supply, 0-15V @ 50A (metered) ... $650
Kepco ATE55-5M, Power Supply, 55V @ 5A ... $425
Kepco BVP100-4M, Bi-Polar Power Supply, 0-100V @ 4A (metered) ... $520
Kepco JQE 36-15MVPT, Power Supply, 0-36 @ 15A (metered) ... $275
Kepco JQE 36-3MVPT, Power Supply, 0-36 @ 3A (metered) ... $175
Krohn-Hite 3202R, Dual Channel Tunable Filter, 20Hz-2MHz, High Pass, Low Pass Band Reject ... $275
Polorad SPNH, Signal Generator, 20Hz-20KHz ... $450
Polorad SPNL, Signal Generator, 1Hz-600KHz ... $350
Racal Dana 9303, True RMS RF Level Meter ... $550
Rockland 1022F, Dual Hi/Lo Filter ... $150
Rockland 5100, Synthesizer, DC-2MHz, .001 Hz Resolution ... $325
Sencore SC61, Scope (100MHz) w/New Probes, Dual Trace ... $750
Sencore SC61, Scope (100MHz) w/o Probes, Dual Trace ... $500
Sencore TVA92, TV Video Analyzer ... $1,100
Sencore VC63, VCR Test Accessory ... $100
Sencore VG91, Universal Video Generator ... $1,200
Sorenson DCR-80-5A, Power Supply, 80V @ 5A (metered) ... $475
Sorenson DCS-300-3.5, Power Supply, 0-300V @ 3.5A (digital readout) ... $375
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Tek TM506, Power Module, 6 Slot ... $200
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Tek PS501-1, Plug-in Power Supply ... $150
Tek T922, Scope (15MHz), Dual Trace, nice ... $175
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Tek 7B92A, Plug-in (500MHz), Dual Time Base ... $200
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Tek 7D13, Plug-in DMM 3-1/2 Digit ... $125
Tek 7D15, Plug-in Counter/Timer, DC-225MHz ... $225
Tek 7S11, Plug-in Sampling Unit ... $175
Tek 134, Current Probe Amp ... $100
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Tek 465B, Scope (100MHz), Dual Trace ... $475
Tek 466, Scope (100MHz storage), Dual Trace ... $575
Tek 475, Scope (200MHz), Dual Trace ... $475
Tek 475A, Scope (250MHz), Dual Trace ... $625
Tek 475/DM44, Scope (200MHz), Dual Trace w/DMM ... $575
Tek 485, Scope (350MHz), Dual Trace ... $850
Tek 520A, NTSC Vectorscope ... $575
Tek 576, Curve Tracer ... $1,500
Tek 2213, Scope (60MHz), Dual Trace ... $375
Tek 2236, Scope (100MHz) w/Counter/Timer/DMM ... $800
Tek 2445, Scope (150MHz), 4-Channel Cursor Readout ... $1,700
Tek 2465, Scope (300MHz), 4-Channel Cursor Readout ... $2,400
Tek 7104, Scope (1GHz), Dual Trace ... $1,750
Tek 7603, Scope Mainframe (100MHz) ... $200
Tek 7704A, Scope Mainframe (250MHz) ... $325
Tek 7854, Scope (400MHz), Dual Beam w/Waveform Calculator ... $625
Tek 7904, Scope Mainframe (500MHz) ... $350
Wavetek 145, Pulse/Function Generator, .0001-20MHz ... $350
Wavetek 185, Lin Log Sweep Generator, .0001Hz-5MHz ... $425
Wavetek 288, Synthesized Function Generator, 20Hz-20MHz (unused) ... $950
Wavetek 751A, Brickwall Filter ... $450
Wavetek 2002, Sweep/Signal Generator, 1-4000MHz ... $950
Wavetek 3000, Signal Generator, 1-520MHz ... $525
Wilcom, T222C, Signaling Test Set (unused) ... $825
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Wilcom 1504, Artificial Line T240 ... $700

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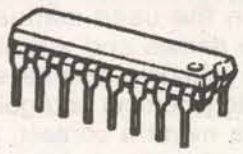

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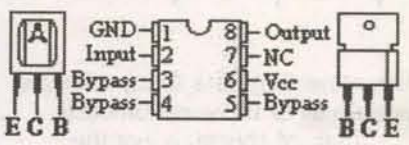

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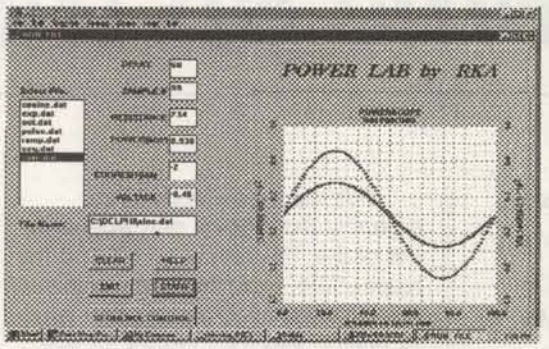

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A Home on the Web

by Karl Lunt

I've long wanted a way to update my web page automatically. I have lots of projects aying around the house capable of gathering data and controlling nearby devices without my help. Hooking a robot or other project to a serial or parallel port on my computer makes it easy to collect a file of data.

But the World Wide Web, arguably the biggest playground on the globe, has remained beyond my reach. Sure, I can make my presence known the old-fashioned way, by dialing into my Internet Service Provider (ISP) and using an FTP-capable program to change pages on my web site. But to do this, I have to get personally involved. I have to turn on the computer, prepare the files to upload, activate the connection, and move the data.

What I want is the ability to handle all phases of the process automatically. In essence, I want a software robot that will gather data on its surrounding environment, frame the information into a data file, move that data to my web site, and do all of this autonomously.

That, of course, is just the beginning of my requirements. Another limit is that my robot must run on a low-end DOS box, similar to the Epson IM-403 cash register computer that I described in a recent *Nuts & Volts* article. This requirement significantly increases the difficulty of the task.

About now, the Linux/Unix hackers out there are probably wondering why the fuss. After all, you can build such a robot with about four commands in a Linux cron file. I don't have anything against Linux; I've often thought of dedicating one of my PCs to use as a Linux platform. But my immediate need is for a DOS-based solution, and I'm sure such a solution would appeal to a larger number of readers than a Linux project.

Then there is my overriding requirement: the solution must be free, or at least incredibly cheap. Part of this is my unwillingness to spend a lot of money for software that will run on a $100.00 computer. The rest of this requirement is my unwillingness to spend any money at all on software.

So the project looks like this: Using cheap, simple software, build a program that runs on a low-end DOS box, can periodically collect data via a serial or parallel port,

Here is my AUTOEXEC.SCR file, used as a startup file by FNOS. I copied this file almost verbatim from Marc Blakely's FNOS distribution file.

```
# ==========================================================
# Basic FNOS configuration file
# 1.7
# Edit '##' lines as needed
# All other lines should work as given.
# (A full list of available options are contained in FULL.NOS)
# ==========================================================

# _____ ATTACH COMMANDS _____
# attach asy <ioaddress> <vector> ax25|nrs|ppp|slip <interface> <buffers> <mtu> <speed>
[<slipoptions>]
# Com1
# attach asy 0x3f8 4 ppp pp0 10 1500 9600
# Com2
##attach asy 0x2f8 3 ppp pp0 4096 1500 115200 f 12
# attach packet <vector> <interface> <txqlen> <mtu>

#  Added 5 June 1998; use COM3
attach asy 0x3e8 4 ppp pp0 10 1500 38800

# _____ DOMAIN SETTINGS _____
# domain addserver <ipaddr> [<ipaddr> ...]
# Primary DNS server
domain addserver 199.181.164.1
domain cache clean on

# _____ ECHO RESPONSE _____
echo accept

# _____ FTP TRANSFER MODE _____
ftype binary

# _____ ICMP SETTINGS _____
# (Internet Control Message Protocol service)
icmp echo on

# _____ IFCONFIG STATEMENTS _____
ifconfig pp0 encapsulation ppp
ifconfig pp0 netmask 0xffffff00
ifconfig pp0 broadcast 0.0.0.255

# _____ AT-TYPE CLOCK FLAG _____
isat on

# _____ LOGGING CONTROL _____
log on

# _____ POINT TO POINT PROTOCOL _____
ppp pp0 lcp local acfc on
ppp pp0 lcp local pfc on
ppp pp0 lcp local accm 0
ppp pp0 lcp local magic on
ppp pp0 lcp local mru 1500
ppp pp0 lcp open active
# this line required for PAP logins - see PAP.DIL
ppp pp0 lcp remote authenticate allow on
ppp pp0 lcp timeout 5
ppp pp0 lcp try configure 40
ppp pp0 lcp try failure 5
ppp pp0 lcp try terminate 5
ppp pp0 ipcp timeout 5
ppp pp0 ipcp try configure 30
ppp pp0 ipcp try failure 5
ppp pp0 ipcp try terminate 5
# This line required for dynamic IP address assignment
ppp pp0 ipcp local address 0
ppp pp0 ipcp local compress tcp 16
ppp pp0 ipcp open active
# This line required for dynamic IP address assignment
ppp pp0 ipcp remote address allow on
ppp pp0 ipcp remote compress tcp 16

# _____ ROUTES _____
route add default pp0

# _____ TCP - TERMINAL CONTROL PROTOCOL SETTINGS _____
tcp irtt 255
tcp mss 1460
tcp syndata off
tcp window 8192

# _____ WATCHDOG AUTO-RESET FUNCTION _____
watchdog on

# _____ FTN EXTENSIONS _____
# ftnopt mode [on|OFF]
ftnopt mode on
# ftnopt logfile [filename]
ftnopt logfile c:\fnos\logs\fnos.log
# ftnopt redialtry [count]
ftnopt redialtry 3
# ftnopt failexit [on|OFF]
# ftnopt failexit on
ftnopt failexit off
# ftnopt delremote [on|OFF]
ftnopt delremote off
# ftnopt dellocal [on|OFF]
ftnopt dellocal off
# ftnopt idletime <seconds>
ftnopt idletime 120

# Execute the additional commands contained in the named script file
source autoexec.scr
```

==========

Here is my AUTOEXEC.SCR file, a scripting file for running FNOS autonomously. Again, much of this was copied verbatim from Marc's files.

```
# autoexec.scr sample script file

# Use the following line for tty type dialer logins
#dialer pp0 tty.dil

# Use the next two lines for a PAP type login
# (Note: Use your real name and password here.)
ppp pp0 pap user karllunt *****
dialer pp0 seanet.dil

# additional commands would come here, ie. ftp, smtp, popmail, etc.

ftp collect.ftp
```

==========

Here is my dialing file (SEANET.DIL), used by FNOS to control the modem when it dials into my ISP, Seanet.

```
#
#  seanet.dil     dialing script for connecting to Seanet
#
failmode off
```

format the data as I want it, and move it to my web page on schedule, all while operating autonomously. Since I've written this article, you can assume I did it. Here's how you can do it too ...

Getting there

Most readers are probably very familiar with the public side of a web page. If you tell your browser to hit my web site at http://www.seanet.com/~karllunt, you will see my home page, a simple display of text with a large banner heading, assorted links, and horizontal lines.

But the back side of my web page — which only I can see — is a group of files containing information couched in HyperText Markup Language, or HTML. I've prepared each of the 30-odd files myself, using some free tools (naturally) that I snorked off of the web some time ago.

After editing my files, I use another free tool to upload the files to my web site, via FTP, or File Transfer Protocol. FTP, which dates back to the earliest days of networking in the Unix world, acts as a universal means of moving files from one Unix box to another. It is so popular and so necessary for working on the Internet that DOS and Windows versions of FTP have been around for years. In fact, Windows 95 comes with a serviceable FTP program, and you probably received an FTP utility from your ISP when you signed up for web access.

So the easiest way to move my data file, once it has been constructed, is to use FTP. But I need a special kind of FTP tool, a DOS-based one that can be invoked from a command line or from a batch file. With this type of utility, I can reduce the steps needed to perform the dial-up and transfer to a single DOS command. I found such a tool with little effort. Just a few minutes of web-searching with Alta Vista turned up FNOS.

FNOS has a long and interesting history. Apparently, the original developer of the code that mutated into FNOS was Phil Karn. Phil's project, known as the KA9Q code for what I can only assume is his ham call sign, acted as a simple TCP/IP network operating system, or NOS. The ham community built on this original code, with contributions from the Demon Internet Services group in the United Kingdom.

Other flavors of this NOS appeared, the most current being FNOS, or Fidonet Network Operating System. Marc Blakely maintains FNOS; you can contact him via lookglas@adrift.harbornet.com on the Internet or at 1:138/146 on Fidonet. You can also download the latest version of FNOS from his web site at http://www.harbornet.com/folks/lookglas.

I originally wanted a simple FTP tool, but FNOS does far more than FTP transfers. Version 1.7b, which I'm using in this project, also supports Telnet, finger, POP3 (for E-Mail), and NNTP (news), among others. As for connections, FNOS can use either an Ethernet connection or modem dial-up, with either PPP or SLIP drivers; the PPP driver handles password authorization (PAP).

FNOS also supports the high-speed 16550 UARTs found in the newer PCs. This is quite a load of features, especially given the price: free. Marc Blakely and all of the people involved in the creation and maintenance of FNOS deserve a lot of credit for their efforts in bringing such a solid utility to Internet users everywhere.

Installing FNOS is pretty simple. Just download the file FNOS17B.ZIP from Marc's web site and copy the file to a separate directory, such as C:\FNOS. Unzip the file, then take some time to read the extensive documentation included in the distribution. The .ZIP file contains four different executables of the FNOS program. The files named NOS.EXE and NOSL.EXE are the full-up and the light versions of FNOS, compiled to run on an 8088-type system.

The files NOS3.EXE and NOS3L.EXE are the same programs as before, but compiled to run on an 80386-type system. The light versions support SLIP, PPP, and FTP; the full versions support the addi-

```
verbose on
control down
wait 2000
control up
wait 2000

#
#  Reset the modem to factory defaults
#
send "atz\r"

#
#  Wait for modem response, first string is success, all others are failures
#
cwait 10000 "OK" "ERROR"

#
#  Configure the modem for this connection.
#  M0 turns the speaker off always (so it doesn't make noise at night).
#  &C1 allows proper control of the DCD line.
#  &D2 sets the carrier control on my Zoom V34X+ modem as needed by FNOS.
#
send "atM0&C1&D2\r"

#
#  Wait for modem response, first string is success, all others are failures
#
cwait 10000 "OK" "ERROR"

#
#  Let the line settle down
#
wait 2000

#
#  Dial Seanet's number
send "atdt206-622-3878\r"

#
#  Wait for the connection response
#
cwait 65000 "CONNECT" "BUSY" "RING\n" "NO CARRIER"

#
#  Exit the dialer - not the same as the command session exit command
#
exit

# Note: the 'ppp pap user' line must be set and enabled for PAP logins
# Note: the 'ppp pp0 lcp remote authenticate allow on' must be enabled also
```

Here is COLLECT.FTP, a file containing FTP commands needed to move data from my system to my web page on Seanet.

```
#
#  collect.ftp      FNOS script to send collected data to my web site
#
#
#  Open an FTP connection to my web site on seanet.  The site name
#  seanet must be defined in the ftnalias.lst file.
#
open seanet
#
#  Change to the local directory that holds the file of collected data.
#
lcd c:\collect

#
#  Send (put) the file on the web site in the main directory.  With
#  the option dellocal set to ON, the data file will be deleted after
#  transfer.
#
put datapage.txt
put datapage.dat

#
#  All done, close the connection.
#
close

#
#  Finally, use the exit command to shut down the FNOS process and execute
#  the onexit.scr script.
#
exit
```

Here is the file FTNALIAS.LST, where FNOS searches for nicknames such as "seanet."

```
# FTN ftnalias lookup file list
#
# Obviously, you need to supply your real loginname and password here.
#
#aliasname  sitename              loginname   password
#
seanet      www.seanet.com         karllunt    *****
```

Here is the file KARL.JOB, used as a task scheduling list for the cron utility. I've trimmed out much of the extensive documentation that normally comes in this file. Note the use of paired backslashes in my command fields, as required by cron.

```
#
#   min hour day month day-of-week [!]command[;[!]command...]
#

0,5,10,15,20,25,30,35,40,45,50,55 * * * * !c:\\collect\\c.bat
6,36 * * * * !c:\\fnos\\n.bat
```

tional utilities mentioned above. Unless I state otherwise, all of the remaining discussions in this article describe using the NOSL executable.

Though the installation is simple, configuring your FNOS system will take some effort and a fair amount of knowledge of your Internet connection. Take the time to read through the FNOS docs, including the FAQ file, and have the connection information from your ISP handy.

Bear in mind that FNOS runs either interactively or from the command line. Some of FNOS' capabilities don't apply when used in command mode, but understanding them will help you better set up your FNOS installation. Plus, you may well decide to use FNOS in its interactive mode someday; it is a very powerful feature of this program, and alone is worth the effort of configuration.

The key to any FNOS session is a file of initial commands, similar to DOS' AUTOEXEC.BAT. In fact, this startup file defaults to the name AUTOEXEC.NOS, though you can use a command-line option to specify any startup file you want.

Commands inside this file tell FNOS how to establish its network connections and what serial ports to use for those connections. This file also holds a huge variety of configuration commands, most of which have already been set up in advance by Marc in his sample file. The setup is so good, in fact, that I only needed to change three or four lines to get my version of AUTOEXEC.NOS set up.

I'll walk you through the basics of my AUTOEXEC.NOS file, included here for reference. Note that FNOS ignores all blank lines in the startup file. Lines containing a pound-sign ('#') in column one are considered comments, and are also ignored. The first line of interest is the attach command, used to tie a serial port to a particular connection. In my case, I used the line:

```
attach asy 0x3e8 4 ppp pp0 10 1500 38800
```

to configure COM3 (at address $3e8, IRQ 4) for use as a PPP connection. This connection will be known to FNOS as pp0; FNOS will exchange data over this serial connection at up to 38.8 kbaud. FNOS can handle multiple simultaneous connections, using a variety of serial ports, so having a name such as pp0 to associate with a connection makes it easier to keep the different connections straight.

In autonomous mode, you will probably only have one connection open at any time, but power-users running in interactive mode will no doubt enjoy the convenience of named connections.

Referring to a COM port by its address rather than the conventional COM number looks like a throwback to FNOS' roots in Unix, and is a bit awkward. If you're running DOS 6.2, as I am, you can use the handy MSD diagnostic tool to determine the addresses of your available ports.

The next command:

```
domain addserver 199.181.164.1
```

tells FNOS how to locate my primary domain name server (DNS). FNOS will use this DNS to locate target machines on the Internet when I request file access.

In preparing your own autoexec.nos, you will need to add the four-field IP address of your ISP in the format you see here. Your ISP should have provided this information for you when you signed up. If not, give their help desk a call or send them some E-Mail and ask.

You can have multiple domain servers by adding additional domain commands. Bear in mind that FNOS will use the LAST domain address server it finds in your AUTOEXEC.NOS file as the primary server.

Nearly all of the remaining commands are left untouched from Marc's original sample. My ISP uses password authorization on connection, known as PAP, so I left in the commands that deal with that protocol. I also left in the commands concerning dynamic address assignment; this lets FNOS verify my Internet address at each connection.

Some ISPs provide you with a new Internet address each time you connect, some don't. If you're not sure, leave in the commands relating to dynamic address assignment.

The last important command appears at the end of the file. This command:

```
source autoexec.scr
```

tells FNOS that after it has finished processing the file AUTOEXEC.NOS, it should open the file AUTOEXEC.SCR and use that file as a script for controlling further actions. If you want to run FNOS in interactive mode, just comment out this command; when FNOS finishes with AUTOEXEC.NOS, it will display an interactive screen and wait for you to enter commands.

Since I wanted to use FNOS in autonomous mode, however, I copied Marc's sample AUTOEXEC.SCR file and began editing it to fit my requirements. I've included my version of AUTOEXEC.SCR here for reference.

This script file takes the place of interactive commands you would normally enter to dial out and establish your PPP connection. The AUTOEXEC.NOS commands told FNOS what serial ports to use for what kind of connection, but so far FNOS hasn't actually tried to connect to anything. Making a PPP connection requires two separate but related commands, as you see here:

```
ppp pp0 pap user karllunt ****
dialer pp0 seanet.dil
```

Remember that I used AUTOEXEC.NOS to tell FNOS how to use COM3 to create a connection named pp0. These two commands finish the job by providing information on my user name and password, and by giving details on how to dial my ISP, Seanet. The first line tells FNOS that PPP connection pp0 requires password authorization (pap), that it should connect as user karllunt, using **** as a password. When you edit your own autoexec.scr file, be sure to enter your real password in place of ****, which obviously is not my real password.

The second of these two commands tells FNOS where to find dialing information for establishing connection pp0. In this case, I've pointed FNOS to the file SEANET.DIL.

The last line in my AUTOEXEC.SCR file contains a set of commands (actually, just one) that FNOS should execute once it establishes connection pp0. Here, the command:

```
ftp collect.ftp
```

tells FNOS to start up the FTP utility, and to execute a series of FTP commands found in the file COLLECT.FTP. FNOS will run these commands just as if I was entering

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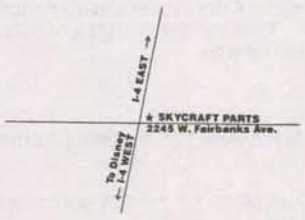

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them from the console in interactive mode.

I've covered the two major FNOS command files, AUTOEXEC.NOS and AUTOEXEC.SCR. Now I can get into the three files specific to my setup. The file SEANET.DIL contains information FNOS uses to establish a dial-up connection to my ISP, Seanet. I've provided that file here for reference.

Much of this script is taken verbatim from Marc's original sample files. I did need to add the modem command line:

```
send "atM0&C1&D2\r"
```

to correct a nasty problem in talking to my Zoom V34X+ external modem.

The modem came out of reset with the &Cx and &Dx parameters both set to 0. This configuration let the modem return an invalid carrier state to FNOS when FNOS tried to dial out. FNOS then reported three failures and exited.

Finding and fixing this problem took much searching through the Hayes AT modem command summaries and a bit of pondering. If you have modem problems or cannot establish a connection through FNOS, remember that FNOS has been used by hundreds, if not thousands, of people over the years. The program works; the problem likely lies with your modem configuration.

A second system-specific file, FTNALIAS.LST, serves as a nickname file for FNOS. When you ask FNOS to make an FTP connection to some site out in the Internet, it is easier if you can refer to that site by a name you understand, such as "seanet."

FNOS, however, needs more specific information before it can complete the connection. The FTNALIAS.LST file translates your nicknames so FNOS can do its job. For example, an entry in my FTNALIAS.LST file:

```
seanet www.seanet.com  karllunt ****
```

lets me use the name seanet when I want to establish an FTP link, yet FNOS knows it must refer to this site as www.seanet.com, log in as user karllunt, and supply password **** when queried by the seanet machine. When you set up your own FNOS system, you can include as many different site descriptions as you like.

After FNOS has processed the SEANET.DIL file, the modem connection will be complete and FNOS will be hooked to my ISP, ready to execute a real set of FTP commands. As I've mentioned, the actual FTP commands I want my software robot to run live in the file COLLECT.FTP, which I've included here for reference.

First off, I use an FTP open command to establish a connection with a site named seanet:

```
open seanet
```

FNOS will use my FTNALIAS.LST file, described above, to complete the handshaking with seanet.com. Next, I need to tell FNOS to use a different directory on my local system for subsequent file transfers. To FTP, the working directory on my machine is known as the local directory, while the working directory on the remote machine (seanet.com, in this case), is known as the remote directory, or just the directory. To change to a different working directory on the local machine, I include the FTP command:

```
lcd c:\collect
```

This causes FTP to use the local directory C:\COLLECT for subsequent file transfers. I then issue a pair of put commands to move two files from my local directory to the working directory on the remote machine:

```
put datapage.txt put datapage.dat
```

Once FNOS has moved these two files, it processes the FTP close command:

```
close
```

to break the FTP session between my machine and seanet.com. Finally, the FNOS exit command:

```
exit
```

terminates the entire FNOS session, hangs up the modem, and returns control to the DOS prompt.

I realize that the number of files involved can look a little intimidating, but the FNOS setup and execution is really quite simple. As you begin the task of configuring your own FNOS system, remember that this powerful program was really developed to handle multiple FTP sessions interactively, a job it does very well. Using it in command-line mode means you have to supply a lot of information normally handled with interactive commands. Thus, you have to spend some time up-front in configuration, but the ease of use once the system is complete makes it all worth while.

Finally, I can enter a single DOS command to start my FNOS system, make the connection to my ISP, transfer two files, and disconnect. That command is:

```
nosl -dc:\fnos autoexec.nos
```

Here, you can see that I'm using the light version of the 8088 FNOS; I've told FNOS to use C:\FNOS as its working directory, and to use the file AUTOEXEC.NOS as its startup command file.

I will point out one small problem I had in setup. The sample files are not completely up to date, and some of the examples don't reflect features introduced in version 1.7b, which I'm using. In particular, the PPP command line in Marc's sample AUTOEXEC.SCR did not include the USER option, though the documentation referred to the option. When in doubt, go with the documentation.

It's about time

But FNOS is only the beginning. Each invocation of FNOS will create a single connection to my ISP, upload a single copy of two different files, and close the connection. To get this sequence of operations to happen repeatedly, when I want it to, requires a utility for scheduling jobs.

Known by the same name as its Unix ancestor, cron lets you specify as many jobs as you want, scheduled whenever you want them, and handles all of the work of starting those jobs on time.

I'm using a shareware version of cron developed for the DOS platform by Tron Hvaring of Norway. This package includes an extensive and well-done manual, last updated in November of 1994. As Tron writes in his introduction, "CRON is a timed command dispatcher that closely implements all the features of the UNIX 'cron' utility that make sense in a DOS environment."

Since DOS isn't a multi-tasking system, running cron means you basically tie up your machine; all it can run is cron. For my purposes, however, that isn't a problem. I just

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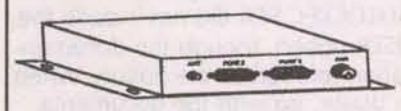

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Write in 125 on Reader Service Card.

need to use cron to schedule uploads to my web site and scans of whatever sensors I want to read. Once everything is going, I can turn the display off and go grab a beer; cron will keep everything running smoothly.

Like its Unix counterpart, this version of cron expects to open a file containing a schedule of tasks to perform; cron uses a file named CRONTAB by default, though a command-line option lets you use any file you want. I chose to use KARL.JOB, and have included that file here for your reference.

To start up cron, I switch to cron's home directory, C:\CRON, then use the command:

```
cron -v -c karl.job
```

This command starts up cron in verbose mode, using the file KARL.JOB as the scheduling file. Verbose mode means cron updates the display with a countdown, so you know which job is next in line and how long before it runs. The -c option tells cron to use the named file for task scheduling, rather then the default file of CRONTAB.

My task file contains just two command lines: one to start the FNOS program for moving data to my web site, and one to run a program called COLLECT.EXE. This latter program, which I wrote in Borland C++, gathers data from sensors and formats it as I want it to appear on my web site. When you set up your own web-aware data collection system, you will need to create or borrow a similar program specific to your needs.

Each entry in a cron scheduling file contains six separate fields, used to define a task and when that task is to start. These fields are separated by one or more spaces, and appear on a line in this order:
minute hour day month day-of-week command

Each of the first five fields, used to define the time and date to start a task, may contain one or more values. If a field contains multiple values, separate each value with a comma. To specify every possible occurrence in a field, use an asterisk ("*"). For example, consider the following sample entry:

```
10,40 8 * * * hoohaw
```

This causes cron to run the program HOOHAW at 8:10 and 8:40 of every day, every month, and every day of the week; that is, daily. cron supports other timing options, as well; check the docs for details.

The command field of an entry holds the full DOS command you want to invoke, complete with any path information, options, or arguments. Note, however, that because of cron's inner workings, you have to be a little careful using backslashes in your command field. cron treats a backslash as an escape character when it parses your command entry, so if you want a backslash in a path, for example, you must use two consecutive backslashes. Thus, the file C:\FNOS\AUTOEXEC.NOS would appear in a cron entry as C:\\FNOS\\AUTOEXEC.NOS. This escape character format is common in C programming, but it can take a little getting used to when it appears in file names.

cron supports some sophisticated features for controlling the amount of memory needed to run applications. You can force cron to swap most of itself out of memory when it starts up an application, freeing more RAM for your job. You can also force cron to invoke a copy of the system COMMAND.COM program when circumstances require it. The documentation contains an excellent discussion of these and other options, and is worth some serious study.

My modest task file hardly pushes cron's capabilities, but the task entries are worth discussing. The first entry:

```
0,5,10,15,20,25,30,35,40,45,5
0,55 * * * * !c:\\collect\\c.bat
```

causes cron to start the batch file C.BAT every five minutes. This batch file invokes the data collection program mentioned earlier, which generates two different output files, DATAPAGE.TXT and DATAPAGE.DAT.

Note the exclamation mark preceding the path name of the batch file. This special character causes cron to run the batch file with a separate copy of COMMAND.COM. Technically, I don't need to tell cron to start a new COMMAND.COM, since the program is smart enough to know it needs to do that for any batch file. The second task entry:

```
6,36 * * * * !c:\\fnos\\n.bat
```

causes cron to start up my FNOS system at six and 36 minutes past each hour. After FNOS connects to my ISP, it starts an FTP session to move the files DATAPAGE.TXT and DATAPAGE.DAT to my web site. These two cron tasks ensure that my web site gets a new set of six data points every half hour, for as long as my DOS box runs.

Time to go

That's how I set up my web-aware DOS-based data collection system. It only took about an hour or so of reading, tweaking, and testing to get the system up and running, and I'm really excited about the possibilities. For example, I could add a form to my web page that I could fill out with various commands.

When FNOS moves the data files to my web site, it could also move this command file back to my system. cron could then invoke this command file, letting me issue commands to my system from anywhere in the world.

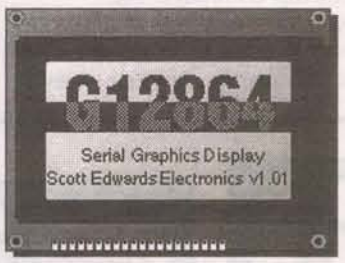
If I made a protected set of commands available to anyone who hits my web site, I could have users from all over the world running, for example, a robot in my workshop.

One of the most intriguing projects I've seen along these lines comes from a web site which address, unfortunately, I didn't save. This guy is installing X-10 remote control devices all over his house, then running them from an X-10 PC gateway which, in turn, will one day get commands from a file he edits on his web page; home control, Internet style!

In the meantime, give this low-cost autonomous means of accessing the Internet a try. I like what it can do, and I really like the price. Have fun! **NV**

Scott Edwards Electronics

NEW! ***Graphics LCD Module with Serial Interface***



3.66" by 2.76"

The new G12864 makes it easy to display text and graphics on a 128-by-64-pixel LCD. It interfaces with a computer through a 2400 or 9600-baud RS-232 serial hookup.

Text Features

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Graphics Features

The display lets you plot points, draw lines, and display full-screen graphics using easy instructions. Its flash memory stores the text font plus 14 screens. You can create fonts and graphics on your PC, then download them to the G12864 using the included software.

Convenience Features

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GRAPHIC LCD DISPLAYS: PART 1

by Ryan Sheldon, National Control Devices (404) 244-2432 http://members.aol.com/ncdcat

You've been asking for it, so, here it is. I'm finally going to show you how to control an LCD display from your desktop PC. Or, if you prefer, you can control a display from a Basic Stamp, or maybe DOS, or maybe some other microcontroller in some other language. The point is, graphic LCD displays are NOT difficult to control, but you do need the tools and the knowledge ... and I think I can help out (maybe just a little) with both.

LCD displays can be very cryptic, so can the controllers, memory allocation, addressing, screen modes, board layout, and the list goes on. So I'm going to address most of these topics by skipping them completely ... you can live without most of this stuff. I'm going to try to provide step-by-step directions that address each of these topics as they become important. After all, the most difficult part of controlling any LCD display is knowing how to take each small step.

LCD Display Types

LCD displays come in one of three basic varieties. Some have built-in control circuitry, while others require external control circuitry. And the dreaded third variety requires a custom controller nobody has access to or has even heard of. These displays are typically found in highly customized mass-produced electronics.

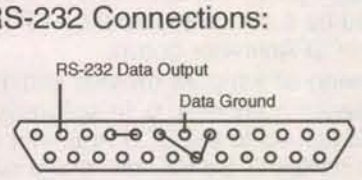
Some displays require a unique, high-speed data transmission that can only be generated by a dedicated display controller chip. Since the controller chip is not mounted directly on the LCD display, it is said to be an external controller. An external controller chip also requires an eight-bit parallel signal to control the display.

The other type of display has the con-

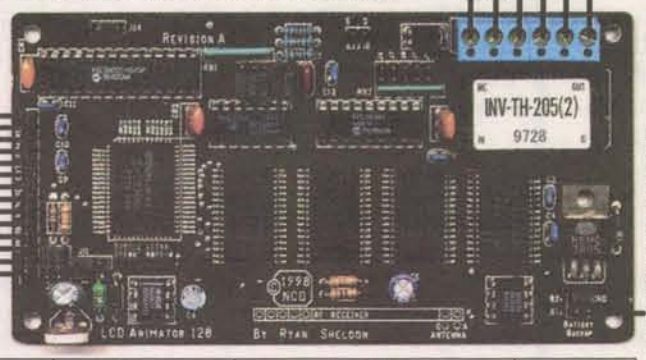
FIGURE 1

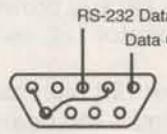
Figure 2: Jumper Settings

RS-232 Connections:



DB-25 Female Connector Shown from Solder Side.





DB-9 Female Connector Shown from Solder Side.

Jumper	Function	Install Notes	Default Setting
J1	Animator Address 1	-	Not Installed
J2	Animator Address 2	-	Not Installed
J3	Animator Address 3	-	Not Installed
J4	Animator Baud 1	-	Installed
J5	Animator Baud 2	-	Not Installed
J6-J10	Reserved	Reserved	Never Installed
J11	Display Type	128 Frames of Graphics (Install Left) 64 Frames of Graphics/Test (Install Right)	Install Between Right Terminals
J12	Display Compatibility	High-Impedence Interface (Install Up) Direct Drive Interface (Install Down)	Install Between Upper Terminals
J13	Display Compatibility	High-Impedence Interface (Install Up) Direct Drive Interface (Install Down)	Install Between Upper Terminals
J14	Animator RS-232 Select	Data From RF Receiver (Install Left) Data from RS-232 (Install Right)	Install Between Right Terminals

Address Setup:

NCD Address	J1	J2	J3
0,8	Removed	Removed	Removed
1,9	Installed	Removed	Removed
2,10	Removed	Installed	Removed
3,11	Installed	Installed	Removed
4,12	Removed	Removed	Installed
5,13	Installed	Removed	Installed
6,14	Removed	Installed	Installed
7,15	Installed	Installed	Installed

Baud Rate Setup:

Baud Rate	J4	J5
9600	Removed	Removed
19,200	Installed	Removed
38,400	Removed	Installed
115,200	Installed	Installed

troller chip built directly into the display. In these cases, the user would only need to provide an eight-bit parallel signal to control the display. While there are numerous advantages to built-in controllers, I personally prefer displays that require an external controller chip, just because I am allowed to customize the components around the controller chip to make it do exactly what I want.

So for now, I want to talk about displays that use an external controller chip. These displays are very common and the power of having the controller chip on a dedicated board cannot be matched by any existing display with a built-in controller.

Specifically, I will be discussing the Epson EG4401 graphic LCD display. The EG4401 is a standard 256x128 graphic LCD display capable of displaying text and graphics. The EG4401 requires an Epson E-1330 (also known as the SMOS SED-1330) display controller chip. For this project, we will be using the NCD LCD Animator 128 to control the display. The LCD Animator 128 has an E-1330 built into the board. In addition, the E-1330 is heavily supplemented with 512K of static ram (SRAM).

The LCD Animator 128 has an RS-232 interface and complete provisions for a software-controlled EL backlight, memory backup protection, as well as the capability of high-speed animation.

The LCD Animator 128 is a storage controller, meaning you can easily store images into the memory of the controller. Once stored, images may be paged using simple ASCII commands. The LCD Animator 128 is capable of animating images at 960 frames per second, making gray-scale imaging possible.

Hardware Setup

Figure 1 illustrates the LCD Animator 128 and a wiring diagram for power, data, EL backlight, and battery backup protection. Connect the LCD Animator 128 as shown in the diagram.

The LCD Animator 128 has many jumpers used to configure the board for your specific application. Figure 1 also illustrates a table of jumpers, their function, and their default settings. Make sure the jumpers are set to the recommended default settings before proceeding.

Initialization

Before the LCD Animator 128 is ready to accept commands, it must first be initialized. Initialization tells the E-1330 specific information about the display that is attached and how to allocate memory for this display. Specifically, the initialization sequence tells the E-1330 that the display is 256 pixels wide and 128 pixels tall. Initialization also tells the controller to configure the screen in text/graphics mode. In text mode, you will be able to display 32x16 lines of text.

Complete directions for initializing the display are included with the LCD Animator 128. But to summarize the process, the included Windows program initializes the display for you so you don't have to write any code. Once initialized, these parameters are stored in memory for as long as power is supplied to the battery backup system. Additionally, a list of ASCII characters is included for direct user-initialization. All you have to do is send these ASCII characters to the LCD Animator 128.

Once initialized, the screen will fill with random garbage on both the text and graphic layers. Once data has been sent to the LCD Animator, this garbage will never be seen again. Think of initialization as a one-time process.

Screen Layers

Graphics and text mode will be treated as separate layers. You may change the text or the graphics layer without affecting the other layer. For example, you can draw an image on the screen and write text to describe the image. You can then change the image without affecting the text layer. Similarly, you may change the text on the screen without affecting the image.

Software

I am going to provide Qbasic programming examples in this article and Visual Basic 5 examples next month in an effort to cover a broad range of users. But before I get started, I have one other topic that must be discussed.

Device Addressing

In the upcoming programming examples, you are going to see several references to device numbers. A device number is a number from 0 to 7 and is used to speak to multiple LCD Animators connected to a single RS-232 serial port. The device number is determined by a set of 3 jumpers — J1-J3 — on the LCD Animator board.

Removing all jumpers (default settings) sets the device number to 0. In software, all commands issued to the LCD Animator must be sent to device 0. So for now, make sure jumpers J1-J3 are removed. And just keep in mind that any time you issue a command to the LCD Animator, the command must include the device number to tell it which device it is speaking to.

Here is a quick example for turning the backlight on or off on multiple devices:

```
Device = 0 : Rem Speak to LCD Animator with J1-J3 jumpers removed.
Status = 0 : Rem Set the Status to 0 to turn off the backlight.
Backligt Device, Status : Rem Call the subroutine that controls the backlight, telling device 0 to turn off the backlight.

Device = 7 : Rem Speak to LCD Animator with J1-J3 jumpers installed.
Status = 1 : Rem Set the Status to 1 to turn on the backlight.
Backligt Device, Status : Rem Call the subroutine that controls the backlight, telling device 7 to turn on the backlight.
```

Qbasic Program Examples

Before running the Qbasic programming example, you must connect the LCD Animator as shown in Figure 1 with jumpers set to their default location as shown. You must also run the "LCD Animator Setup Utility" to initialize the display from Windows 95 (or 98). Remember, the display will remain initialized until batteries are removed from the controller.

Programming the display is not difficult. The following source code shows you how it is done. The program will be dissected in explicit detail in an effort to demonstrate how each individual function works.

Note: You may download this program from my web site at http://members.aol.com/ncdcat/.

Qbasic Program Dissection

The first thing Qbasic needs to do is declare all the subroutines that will be used to control the display. Once the subroutines are declared, a simple command set will be defined making it very easy for users to control each display function.

```
DECLARE SUB WATE (tim!)
DECLARE SUB FRAME (Device!, FRAM!)
DECLARE SUB CLRGRA (Device!)
DECLARE SUB SPED (Device!, File$)
DECLARE SUB CLRTXT (Device!)
DECLARE SUB TEXT (Device!, XPos!, YPos!, TXT$)
DECLARE SUB LIGHT (Device!, Status!)
DECLARE SUB Wake (Device!)
DECLARE SUB CD (Device!, Status!)
DECLARE SUB SENDBYTE (Device!, Byte!)
DECLARE SUB CMD (Device!, Byte!)
DECLARE SUB DAT (Device!, Byte!)

'Open the RS-232 Port for Communications
OPEN "COM2:19200,N,8,1,CD0,CS0,DS0,OP0" FOR
   OUTPUT AS #1
```

The command above demonstrates how to open the serial port in Qbasic. Note that COM2 is used in this program. You may need to switch the COMM port to 1 depending on how your system is configured. Other parameters include baud rate (19.2K), Parity (N=None), 8 Data Bits, and 1 Stop Bit. The remaining portion of this command (CD0,CS0,DS0,OP0) disables hardware handshaking. The "FOR OUTPUT" defines the serial port as an output device. The "AS #1" is the "software channel" where data will be sent out.

Note: The hardware must be set to receive data at 19.2K baud. Remove jumper J5 and install jumper J4 to set the LCD Animator to 19.2K baud.

Later in this program, you will see a "Print #1, CHR$(n);". The #1 is the software channel, defined as a serial port in the open statement above. The CHR$(n) means you will send an ASCII character out the port. The "n" is the ASCII value from 0 to 255. The ";" at the end of the statement is required for correct transmission out the serial port in QBasic. Visual Basic will NOT require the semicolon.

```
Device = 0:    REM Set the Software Device Number
LIGHT Device, 1:   REM Turn On (1) Backlight of device 0
```

Above is our first reference to Device and LIGHT. In the example above, LIGHT subroutine will be called to turn on the backlight of device 0.

```
Wake Device:    REM
  Wake up device 0
```

The Wake subroutine is used to awaken the LCD Animator from sleep mode and begin to display data on the screen. Your program should always begin by waking from sleep mode. I will discuss the sleep mode in greater detail later.

```
FRAME Device, 1:  REM
  Set the Current Frame
  Number to 1
```

The LCD Animator holds 128 frames of graphic pages or 64 frames of graphics/text pages. The FRAME command is used to tell the display at device 0 to go to frame 1 of the display. Think of LCD Animator frames as animation frames; they are essentially the same, only these frames are digitally controlled.

```
CLRTXT Device:    REM Clear the Text Frame
```

The CLRTXT subroutine is used to clear the text layer of the display. Again the device number is 0, meaning that the text layer will only be cleared on an LCD Animator board set to device 0 by removing jumpers J1-J3.

```
CLRGRA Device:    REM Clear the Graphic Frame
```

The CLRGRA subroutine is used to clear the graphics layer of the display. Note that CLRGRA and CLRTXT only clear the graphic and text layers on the selected frame. Anytime you use the FRAME command to change frames, you may need to clear the graphics and text layers depending if the frame has an image (and/or text) stored in it.

```
'Write text starting at column 4 of line 1
TEXT Device, 4, 1, "Another Great Product From"
TEXT Device, 5, 3, "National Control Devices"
TEXT Device, 7, 14, "The LCD Animator 128"
TEXT Device, 10, 16, "By Ryan Sheldon"
```

The TEXT subroutine is used to write text to the display. The TEXT subroutine is called in the following format: TEXT Device, X, Y, txt$. X and Y are used as horizontal and vertical starting locations for the text cursor, allowing you to position text ANYWHERE on the display. The txt$ variable stores the text that is to be written to the display.

```
'Upload a SPEED file graphic to Display
'created by the LCD Animator Setup Utility
SPED Device, "A:\BMP\001.SPD"
```

The Windows-Based LCD Animator Setup Utility allows you to create speed files. A speed file contains 4096 data entries that represent a 256x128 graphic image. The SPED subroutine is used to load and display these speed files as images on the screen of the LCD display. I will talk more about this later.

```
FRAME Device, 2:  REM Set the Current Frame
  Number to 2
```

The FRAME subroutine is called once again to change the page. The idea here is to fill another frame of the display with new graphics and text. Later, we will cycle between these frames forming a simple example of a presentation (a two-frame animation).

```
CLRTXT Device:    REM Clear the Text Frame
CLRGRA Device:    REM Clear the Graphic Frame
```

Now that a new frame has been selected, the CLRTXT and CLRGRA subroutines will be used to clear both graphic and text layers.

```
'Write text starting at column 1 of line 1
TEXT Device, 1, 1, "Presenting Dinosaurs that
  Bite"
'Upload a SPEED file graphic to Display
'created by the LCD Animator Setup Utility
SPED Device, "A:\BMP\016.SPD"
```

New text and graphics will be loaded into frame 2 of the display. Remember, up to 64 frames of text and graphics are supported by the LCD Animator 128.

```
'Switch Between Frames of the Animation
DO
  FRAME Device, 1 : Rem Switch to Frame 1 of the
    Display
  WATE 60
  FRAME Device, 2 : Rem
Switch to Frame 2 of the
Display
  WATE 60
LOOP
```

The above loop cycles between frame 1 and frame 2 of the display. The WATE subroutine is used to create a delay between frame changes. Without a delay, the LCD Animator can easily display data at 960 frames per second.

```
CMD Device, 83:  REM
Send the sleep command,
Display will go blank

CLOSE #1
```

Any well-written program will close the serial port as shown above. This particular program example will never close the serial port because an infinite loop is used to switch between frames 1 and 2 of the display. But the example is provided just in case you need it.

The magic for controlling this display (as you probably guessed) lies in the subroutines. Each subroutine performs a specific function. Some subroutines are called by the user, others are called only by other subroutines. For example, the CD subroutine is never called by the user. The CD subroutine determines whether the E-1330 is in command or data mode. The user will never directly tell the E-1330 which mode to accept data in, but other routines will. The CD subroutine is outlined in greater detail below.

```
SUB CD (Device, Status)
  'Compute Device Number
  DEV = (Device + 8) * 16
  IF Status = 1 THEN
   'Turn On CD Line
   PRINT #1, CHR$(DEV + 3);
  ELSE
   'Turn Off CD Line
   PRINT #1, CHR$(DEV + 2);
  END IF
END SUB
```

The CD subroutine above determines whether the E-1330 is in command or data mode. Command mode is used for operations like positioning the cursor on the screen while data mode is used for writing actual text or graphics to the display.

```
SUB SENDBYTE (Device, Byte)
  'Compute Device Number
  DEV = Device * 16
  'Compute Least Significant Nibble
  LSN = (Byte AND 15)
  'Compute Most Significant Nibble
  MSN = (Byte AND 240) / 16
  'Send Least Significant Nibble
  PRINT #1, CHR$(LSN + DEV);
```

FIGURE 1

```
'Send Most Significant Nibble
 PRINT #1, CHR$(MSN + DEV);
END SUB
```

The SENDBYTE subroutine above is used to send ASCII data to the parallel port pins of the E-1330. Data is interpreted by the E-1330 as a command or as screen information (data) based on the status of the CD subroutine. The Byte variable will always be a decimal value of 0 to 255 (or &H00 to &HFF Hex). LSN and MSN are used to break a byte into 2 nibbles (Least and Most Significant Nibbles). DEV is computed and summed with LSN and MSN to determine which device to speak to.

You will never directly use the SENDBYTE subroutine, so don't spend a lot of time trying to understand it. I will show you some shortcuts later. So, if you plan on porting this code to another language, translate each instruction as it is presented and never look back.

```
SUB CMD (Device, Byte)
 'Turn On CD Line of Display to
   Put in Command Mode3
 CD Device, 1
 'Send a Data Byte
 SENDBYTE Device, Byte
END SUB
```

Commands are sent to the E-1330 directly by the user. A Device number (from 0 to 7) is used to determine which LCD Animator is going to receive the command. Byte is an E-1330 specific command. A few examples of data that can be sent to the display will be shown later. Just remember that CMD is used to send commands for things like positioning the cursor on the screen, or putting the LCD Animator to sleep, or waking it up.

```
SUB DAT (Device, Byte)
 'Turn Off CD Line for Data Mode of Display
 CD Device, 0
 'Send Data Byte
 SENDBYTE Device, Byte
END SUB
```

The DAT subroutine is used to send data to the E-1330 display controller chip. The DAT subroutine is used for writing actual screen information to the display, or providing parameters to a command issued by the CMD subroutine.

The CLRGRA is used to clear the graphic screen of the display. A Device number is passed to the subroutine to control which of eight possible displays will have its graphic screen cleared.

```
SUB CLRGRA (Device)
 'Home the Cursor in the Graphic Screen
 CMD Device, &H46 : Rem Send the Cursor
   Positioning Command
 DAT Device, &H0 : Rem Send the Data for the
   Actual Cursor Position
 DAT Device, &H2 : Rem Send the Data for the
   Actual Cursor Position
```

The command "CMD Device, &H46" tells the E-1330 that you want to position the cursor somewhere on the screen. Technically speaking, this command allows you to move the address pointer anywhere in memory. The subsequent DAT commands specify an exact location to move to in memory. In this case, the cursor is positioned at the beginning of the graphics screen.

All commands are sent in hexadecimal. If you prefer, you may hex values to decimal.

```
 'Issue the write command
 CMD Device, &H42
```

Once the cursor has been positioned, you must issue the Write command. The Write command tells the E-1330 that all subsequent data is to be written to the screen.

```
 'Send blank data to the screen
 FOR n = 0 TO 4095
  DAT Device, &H0
 NEXT n
```

The for/next loop above writes a value of 0 to each of the 4,096 possible memory locations, effectively clearing the screen. If you were to change the DAT command above to read "DAT Device, &HFF", the graphic screen of the display would be filled by turning all pixels on. The display updates as data is received.

FIGURE 3

```
END SUB

SUB CLRTXT (Device)
 'Compute Device Number
 DEV = Device * 16
 'Home the Cursor
 CMD Device, &H46
 DAT Device, 0
 DAT Device, 0
 'Issue the Write Command
 CMD Device, &H42
 'Send Text to the Display 1 character at a time
 FOR aa = 1 TO 512
  DAT Device, 32: REM Send SPACE character,
   ASCII 32
 NEXT aa
END SUB
```

The CLRTXT subroutine above is responsible for clearing the text. CMD &H46 is used to set the cursor position. The Subsequent DAT commands set the cursor to the beginning of memory, in the text layer.

Note that there are 512 total ASCII characters that can be displayed on the screen simultaneously. So to clear the text screen, this subroutine does three things: **1)** Positions the cursor at the beginning of memory (located at the upper left corner of the screen). **2)** Issues the write command for changing the contents of memory. **3)** Sends 512 SPACE characters (ASCII 32 is the SPACE character). Try changing the value of the 32 to a 65 and see what happens.

The FRAME subroutine below is responsible for changing frames on the display. As frames are changed, the display updates the image and text. To animate images, all you

have to do is load images into each frame of the display memory, then issue the frame change command to cycle through the animation frames.

Memory is organized in hardware by chapter and page. This routine is simply converting a number from 1 to 64 to a chapter and page number. Think of the LCD Animator as holding 4 chapters, with 16 pages in each chapter, or 16x4 frames of text and graphics.

```
SUB FRAME (Device, FRAM)
  'Compute the Device Number
  DEV = (Device + 8) * 16
  'FR Can Equal 0 to 15 Only
  FR = FRAM - 1: Chapter = 1
  'Count Up the Chapters in Increments of 16
    Pages
  WHILE FR > 15
   Chapter = Chapter + 1
   FR = FR - 16
  WEND
  'Send the Page Change Command
  PRINT #1, CHR$(DEV + 4)
  'Send the Page to Go to (FR=0 to 15)
  PRINT #1, CHR$(DEV + FR)
  'Send the Chapter Change Command with
    Chapter
  PRINT #1, CHR$(DEV + 5 + Chapter)
END SUB
```

The LIGHT subroutine is pretty self explanatory. Device is a number from 0 to 7 while Status is either a 1 or a 0. Sending a Status of 1 turns on the backlight, and 0 turns it off.

```
SUB LIGHT (Device, Status)
  'Compute Device Number
  DEV = (Device + 8) * 16
  IF Status = 1 THEN
   'Turn On Backlight
   PRINT #1, CHR$(DEV + 1);
  ELSE
   'Turn Off Backlight
   PRINT #1, CHR$(DEV + 0);
  END IF
END SUB
```

The SPED subroutine below is designed to read and display SPD speed file graphic images. SPD files are created using the included LCD Animator Setup Utility (for Windows 95/98). Speed files contain 4,096 bytes of data that represent each and every byte of memory shown directly on the screen.

This subroutine works by opening a SPD speed file from the disk. A byte is read directly out of the file, and then sent directly to the display. As each byte is read and sent, each byte of data appears as a set of eight pixels on the display, effectively filling the display with contents of the data in the file, forming the image.

```
SUB SPED (Device, File$)
  'Home the Cursor in the Graphic Screen
  CMD Device, &H46
  DAT Device, &H0
  DAT Device, &H2
  'Issue the write command
  CMD Device, &H42
  'Open Data File
  OPEN File$ FOR INPUT AS #2
  INPUT #2, A$: REM Read the
    header and discard contents
  'Read the rest of the file
  FOR n = 0 TO 4095
    INPUT #2, A:  REM Read Data
    Byte from File
    DAT Device, A: REM Send
    Data Byte to Display
  NEXT n
  'Close the Data File
  CLOSE #2
END SUB
```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http://members.aol.com/ncdcat/

The LCD Animator and EL Backlit LCD Display are available to readers of this article for just $199.00. You must mention this article when ordering.

A display controller is essentially useless if it cannot display text quickly and easily. The following subroutine displays text of any length at any position of the screen. Xpos and Ypos hold X and Y screen locations for displaying text. So a value of 1,1, "A" would put the letter "A" in the upper left corner of the screen. On the EG4401, you can display 32 characters across the screen with 16 lines.

```
SUB TEXT (Device, XPos, YPos, TXT$)
  'Compute Device Number
  DEV = Device * 16
  'Setup Display for Text Positioning
  CMD Device, &H46
  'Determine Linear Cursor Position on the Text
    Screen
  CPos = (XPos - 1) + ((YPos - 1) * 32)
  'Position the Curson on the Display
  IF CPos <= 255 THEN
    DAT Device, CPos
    DAT Device, 0
  ELSE
    DAT Device, CPos - 256
    DAT Device, 1
  END IF
  'Issue the Write Command
  CMD Device, &H42
  'Send Text to the Display 1 character at a time
  FOR aa = 1 TO LEN(TXT$)
    DAT Device, ASC(MID$(TXT$, aa, 1))
  NEXT aa
END SUB
```

The For/Next loop at the end of the TEXT subroutine is used to count through each of the letters in the TXT$ string. Letters are converted and sent out the port using the DAT subroutine call.

The LCD Animator completely supports the sleep and wake commands. It is very important to put the LCD Animator to sleep BEFORE removing power to retain display memory. The LCD Animator supports two methods of putting the controller to sleep: software and hardware. You can issue the sleep command in software by simply sending CMD Device, &H53.

If you issued the software sleep command, you can issue the following wake command to turn the display back on. The wake command is automatically sent every time power is applied to the board. But the wake command will not work if you put the LCD Animator to sleep using the hardware sleep method.

The only way to wake up an LCD Animator from hardware sleep is to do a power down, and subsequent power up.

```
SUB Wake (Device)
  'Send Wake up commands to the LCD Animator
  CMD Device, &H40: REM System Set Command
  DAT Device, &H38: REM First Parameter of the
    System Set Command
  CMD Device, &H59: REM Turn the Display On
  CMD Device, &H4C: REM Tell Cursor to Move
    Right
END SUB
```

The following WATE command is used to create a simple delay between frame changes. The variable "tim" determines the delay time.

```
SUB WATE (tim)
  FOR Delay = 1 TO tim * 3000
  NEXT Delay
END SUB
```

Display Varieties

The EG4401 comes in many variations depending on the aesthetic requirements of your application. While a reflective model is available, most are EL backlit. EL stands for Electro Luminescent and consists of a very thin laminate energized by a high-voltage AC source.

An EL inverter is all that is required to energize the laminate, effectively converting +5 volts DC to 100 volts AC. EL inverters are made by many companies and are available from Digi-Key.

Different variations of EL laminate and polarizers are often used to achieve different effects. Figure 2 illustrates a standard white EL backlight with a standard positive polarizer. Figure 3 illustrates a colored laminate with a negative polarizer.

In this example, the EL laminate is colored with a blue transparent film and the polarizer is reversed. The resulting image consists of white pixels on a royal-blue background. Since the polarizer is reversed, images may need to be inverted before they appear correctly on the screen.

Well, I think that about raps it up for now. Next month, I will provide some detailed Visual Basic 5 programming examples.

If you have any questions or comments, please feel free to call me at (404) 244-2432 or write NCDRyan@aol.com. **NV**

Y2K: Armageddon in less than 500 days…and counting!

Many experts predict the "millennium bug" will wreak worldwide havoc. And it may. But you can be prepared with Eurosoft's fix2000, a quick, effective and affordable solution to computer problems brought on by the end of the century.

by June Habbard

Almost a thousand years ago, prophets and prognosticators predicted that a host of disasters would befall civilization at the end of the first millennium. Now, as we near the year 2000, doomsayers are again predicting dire consequences, this time as the result of computer malfunctions. The results could be devastating—aircraft radar may malfunction, financial markets could crash and almost every automated system in the world could be thrown into a state of complete chaos. The so-called Y2K problem has puzzled computer experts for years, but now an innovative company has developed a way to solve the problem quickly, permanently and affordably. EuroSoft's fix2000™ provides immediate support for this troubling problem. You can choose either the software version or the ROM add-on board.

Sooner than you think. Although the Y2K problem has only recently been addressed in the national media, computer experts and government officials have known about the impending problem for years. The problem exists because, until recently, most computer hardware and software stored and displayed a particular year as a two digit number. The computer sees 98 and understands the year to be 1998. Once the year 2000 is reached, most computers will continue to use the last two digits of the year as though they were preceded by "19," causing the internal date of the computer to be 1900. This will cause a multitude of problems for computers around the world. The effect of this problem is difficult to estimate, but predictions range from a global recession to a worldwide shutdown of automated systems.

What we are facing in the year 2000!

The millennium bug could affect everything from wall clocks to air traffic control systems. Many computer users, plus businesses large and small, believe that the problem is out of their hands. Experts are saying:

- Up to 50% of businesses worldwide will experience failure of critical systems.
- Software fixes alone may reach $600 billion.
- Only 63% of the population knows about the problem.
- Only 25% of small companies world wide are reprogramming their computers.
- 90% of midsize retailers are using non-year 2000-compliant systems.
- Less than 50% of I.R.S. computers have been updated.
- Nearly 40% of the US Treasury Department's systems won't be ready for the year 2000!

No solution...until now. Government agencies and large corporations have been trying to remedy this problem, but there has been no simple solution. Because the century portion of the date is simply fixed or static on a display of a report, there is no way to change the date to include the "20" prefix. Because of the sheer size of the databases involved, going back and changing the programming language itself is at best, extremely costly and at worst…futile. Left unresolved this problem will create a variety of difficulties for not only large companies and government agencies, but for individual computer users as well. If you think that this problem will fix itself…think again.

Fix it for good. The diagnostic software of fix2000 is now being used throughout the world, giving computer users confidence in the reliability of their hardware. Proven effective by independent consultants, fix2000 provides the very best in Y2K compliance. It allows both commercial and individual PC users to quickly identify and correct the year 2000 rollover problem, even without knowledge of PC hardware. Many so-called "Millennium Compliant PCs" claim to perform the correction, but in many cases, the loss of crucial data is still a distinct possibility. The fix2000 solution checks the PC's hardware, revealing whether the date rollover process is supported or not. By installing the correction program, fix2000 ensures that the correct date information is automatically made available when requested by an application program.

Why Buy fix2000?

- Once installed your PC will remain compliant indicated by a "fix2000" message on start-up.
- Self boot testing avoids conflicts with operating system.
- Displays bold warning messages if "fix2000" is removed keeping you fully compliant and protected.
- "fix2000" automatically corrects all PC clocks
- "fix2000" received 100% rating in the Solace Consultancy Millennium report, viewed by Task Force 2000.

Don't wait! The fix2000 solution comes complete with the Y2K compliance test software and the fix program on floppy or ROM. It's easy to install and a snap to use, so call today and make your computer 2000-compatible…for good. (Due to the nature of this product, Comtrad's risk-free home trial does not apply.)

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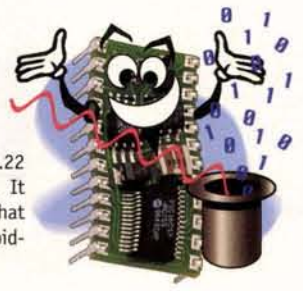
12-bit A/D Convertor AppKit (#27916 - $26)



The LTC1298 12-bit A/D convertor provides 1.22 millivolt resolution (with 5-volt reference). It has an internal sample-and-hold feature that prevents errors when it is used to measure rapidly changing signals.

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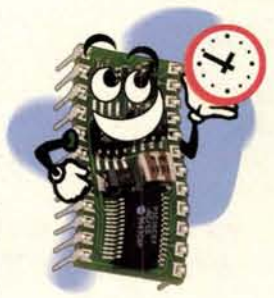
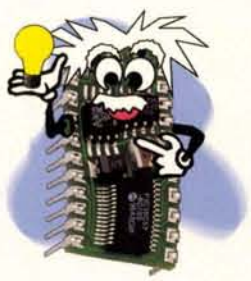


The DS1302 is a real-time clock / calendar with 31 bytes of static RAM. The 1302 counts seconds, minutes, hours, date of the month, month, day of the week, and year with leap year compensation. Requires 2.5 - 5.5 volts for full operation, and uses less than 300 nA at 2.5 volts. Adding real time to your BASIC Stamp is now quite easy.

DTMF Transceiver AppKit (#27915 - $26)

The CM8880 is a dual-tone, multifrequency (DTMF) transceiver on a chip. It can be configured to send or receive "touch" tones used in many phone and radio communication systems. The BS2-IC generates DTMF tones, and the CM8880 introduces two-way communication with it's decoding capabilities.



8k Serial EEPROM AppKit (#27918 - $26)

The X25640 is an electrically erasable, programmable, read-only memory (EEPROM) device with 8192 bytes (8kB) of storage. Xicor says that the X25640 will survive a minimum of 100,000 writes. Data stored in the EEPROM should remain intact without power for 100 years or more. Perfect for storing Stamp calibration tables, control settings, programs, maintenance logs, and small databases.

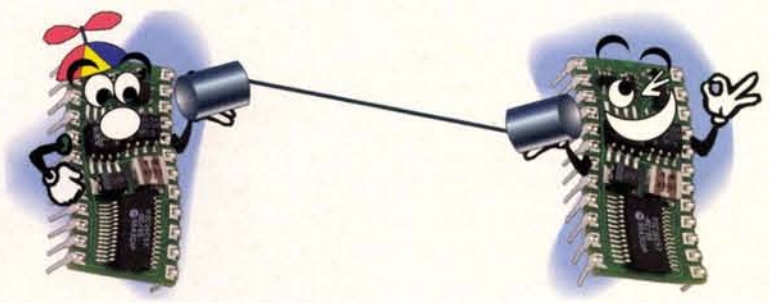
Digital Thermometer / Thermostat AppKit (#27917 - $26)

The DS1620 is a complete digital thermometer on a chip, capable of replacing the normal combination of temperature sensor and analog-to-digital converter. Measures temperature in units of 0.5° Centigrade (C) from -55° C to +125° C. Using a simple three-wire connection to your BASIC Stamp, this code reads temperature from the DS1620:

```
shiftin DQ,CLK,lsbpre,[DSdata\9]
```

8-digit LED Display Driver AppKit (#27914 - $26)

The MAX7219 drives common-cathode LED displays from one to eight (seven-segment) digits in length. It can also be used to drive up to 64 discrete LEDs configured as eight common-cathode clusters of eight LEDs each. Least expensive way to interface a human to your project.



RS-485 Long-Distance Communication AppKit (#27934 - $29)

Network your BASIC Stamps up to 4,000 feet using the Texas Instruments SN75176 transceiver chip. This network can easily be expanded to include 32 BASIC Stamps. This simple command sends a string of characters over an RS-485 network at 2400 baud on a BASIC Stamp 1:

```
SEROUT 1,N2400,("Warehouse temperature is ", temp)
```

Check our web site at http://www.parallaxinc.com or call us if you'd like to discuss which BASIC Stamp is best for your project. Parallax BASIC Stamp Starter Kits include the module, carrier board, manual with 26 application notes, software and a programming cable.

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